GODDARD

ON THE

TEETH.

WITH 30 PLATES.

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THE

ANATOMY, PHYSIOLOGY AND PATHOLOGY

OF THE

HUMAN TEETH;

WITH THE

MOST APPROVED METHODS OF TREATMENT;

INCLUDING OPERATIONS,

AND THE

METHOD OF MAKING AND SETTING ARTIFICIAL TEETH.

WITH THIRTY PLATES.

BY

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AIDED IN THE PRACTICAL PART

BY

JOSEPH E. PARKER, DENTIST.

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TO

WILLIAM EDMONDS HORNER, M. D.,

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF PENNSYLVANIA,

MY OLD AND WELL TRIED FRIEND,

THIS WORK

IS RESPECTFULLY DEDICATED.

P. B. GODDARD.

PREFACE.

The author's apology for presenting this work to the profession at the present time, will be found in the demand which has existed for some years, for a plain practical treatise on the subject of the teeth, and particularly on the manufacture of porcelain, which has attained a high stand at this time; and it is hoped that the statement, that better teeth of this kind are made in this country than in any other, will not be attributed either to a desire to boast, or an ignorance of the condition of the art in other portions of the world. It is not presumed that the practical dentist, of age and experience, can derive much from a work like the present; but his attention is particularly desired to the microscopic anatomy of the teeth, and to the pathology of decay which is founded upon it. Although it will be seen, that many of the microscopic views have been taken from Retzius, yet every one has been most carefully verified by the author, by means of a very fine microscope in his own possession, and another in the hands of his relative, Dr. C. F. Beck, whose liberality has made him the fortunate possessor of an instrument, not surpassed at the present time. It will readily follow, if this description is correct, (and it is put forth with the utmost confidence,) that the usual notions which prevail on the subject of decay, miscalled *caries*, must yield to a better and more correct pathology, and consequently, to a more scientific and less empirical practice. In the practical portion of the work, minute directions will be found for the extraction of the teeth, with forceps of a moderate size, and it is hoped that this portion of it will prove highly acceptable to the physicians of the South and West, some of whom occasionally excite the risibility of our dentists, by the enormous length of the *pullekins* which they order for their especial use; orders which arise from the absence of instructions, for the application of less formidable and better instruments. Under the head of Porcelain Teeth, will be found full directions for obtaining the necessary substances and combining them for use, as well as the mode of making the plates, solder, &c., from coin which can be obtained almost anywhere. The mode of

burning and enamelling, is also accurately detailed; and although the dentist at a distance from a large city, may find it difficult to get the furnace and accompaniments, a little ingenuity will soon supply their place, when he knows what to imitate.

For the practical details contained in the latter portions of the work, the author is indebted to Mr. Joseph E. Parker, whose name appears on the title, and who has contributed the desired information without withholding what is too often retained by individuals as among the secrets of the trade; a circumstance which degrades, what ought to be the *science* of dentistry, into a mere art. The author, however, takes occasion here to express his obligations to many of the profession, who have aided him by the loan of instruments, and the privilege of making drawings; being particularly desirous of thanking Doctors Gardette and M'Grath, Surgeon Dentists, and Messrs. Stockton and Kern, manufacturers of teeth and instruments.

The drawings from which the plates were lithographed, were executed under the author's own eye, by an excellent and meritorious young artist whose name appears on the plates, and whose delineations are faithful copies of the objects represented.

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EXPLANATION OF THE PLATES.

The explanations accompany each plate.

PART FIRST.

GENERAL CONSIDERATIONS.

CHAPTER FIRST.

THE HISTORY OF THE TEETH.

1. In a work like this, professing to give a complete account of the teeth, it would be manifestly improper to omit a history of the commencement and progress of the knowledge on the subject, which has in the present age been so highly perfected. In this detail the horrible operations and awkward and ill-contrived instruments of the early ages will hold a place.

2. The first account which we have of any attention being paid by mankind to these organs, is from Herodotus, who states that the Egyptians at a very remote period confided the care of the teeth to a particular set of persons, but it does not state in what the care of them consisted, and it probably was confined to extracting them. Among a very large number of skulls belonging to Dr. S. G. Morton, I have found no evidence of the rude extraction of the teeth nor of the loss of alveoli, which must have attended their operations, unless they had acquired a degree of skill which they are not credited with. In Rossalini's great work there is a figure representing a doctor dragging something out of the mouth of a patient, looking amazingly like tooth-drawing, and copper forceps or pincers were found in the offices supposed to belong to *barbers*, who were most probably their only dentists. There is no doubt, therefore, that dentistry as a distinct and separate art had its origin in ancient Egypt, and there is good reason to believe, that it descended from father to son, so that great proficiency *might* have been attained.

3. Hippocrates, who lived about 350 years before Christ, the first correct observer and the first good physician that the world ever saw, gives a most amusing account of the origin and development of the teeth. He says, "There is a glutinous increment from the bones of the head and jaws, of which the fatty part is dried by heat and burnt up, and the teeth are made harder than the other bones, because there is nothing cold in them." He says that they are nourished in the womb by the food of the mother, and when the infant is born, by the milk which it sucks!!

4. He describes, however, in a rude way their several diseases, and concludes by recommending them to be removed when they are rotten and *loose*. He, however, describes no instruments, leaving it probable that the fingers alone were used, as he only took them out when *loosened*. He also recommends the application of the actual cautery, and describes

a mode of fixing them with gold wire when the jaw has been fractured. To give an idea of the dentifrices used at this early period, we add the following from the works of the same author. "Take the head of a hare and three mice, burn and reduce them to powder and mix them with an equal weight of powdered marble." Here we have animal charcoal and prepared chalk with a vengeance.

5. Aristotle, the pupil of Plato, exhibited great ignorance of these organs, as he states that the male sex possessed more teeth than the female; and again, that all animals who bring forth their young alive have teeth, although not always in both jaws. Many other absurd statements exist in his writings which it would be needless to repeat.

6. Eristratus speaks of leaden forceps in the Temple of Apollo, and endeavours to deter persons from extracting the teeth; and Herophilus relates several cases where death attended this operation.

7. Celsus, however, gives the first regular directions for extracting the teeth. His plan was to imitate the natural loosening of the teeth by *shaking* them well in the jaw and subsequently extracting them. A most delightful operation, particularly as performed by the *vulsella*, which is represented at Plate XXV. figure 1, and bears some resemblance to our hawk's-bill forceps. Some idea of the severity of the operation may be formed from the fact that Celsus preferred the application of the hot iron or boiling oil to the teeth to make them exfoliate.

8. Aretæus asserted that the cause of the toothache was only known to God.

9. Pliny, who lived 400 years after Aristotle, discovered the indestructibility of teeth when compared to bones.

10. Galen, two centuries after Christ, wrote the best account of the teeth which had yet appeared, being correct in many particulars; but he considered them true bones, and maintained that they possessed sensibility, and his surgery was any thing but commendable.

11. Aetius says the teeth are open at the roots, and are supplied by a nerve from the trifacial, and recommends stopping them when decayed with wax and galbanum. He also recommends filing the teeth to get them into shape when irregular.

12. Rhazes, the *prince of physicians*, gives a very imperfect account of the teeth.

13. Albucasis, the *prince of surgeons*, is the first to recommend the supplying the teeth when lost by other human teeth, or those of the sheep, or by artificial ones made of bone. His mode of extraction was first to scarify the gum, then to *shake* the tooth well in its socket, and finally to pull it out perpendicularly. His instruments are rudely figured, Plate XXV. figures 2, 3, 4 and 5. He directs the head of the patient to be put between the knees of the operator to keep it steady, and if the tooth does not shake well, a lever is to be inserted all around and the tooth loosened in that way. Albucasis, like his predecessors, prefers the application of red heat or boiling butter, and gives the figures of two instruments for applying them; see Plate XXV. figures 6 and 7.

14. Vesalius, born about 1512, considered the milk teeth as the germs of the permanent ones; whilst Eustachius gives a description of the two sets, and compares their adhesion to the gums to that of the nails. He also describes the difference between the enamel and

the rest of the tooth, and compares it to the bark of a tree, and is satisfied that the germs of both sets exist in the fœtus.

15. Ambrose Pare', in 1579, gives a very good account of the teeth, and states *that their adherence to the jaw is caused by a ligament which goes from the root of the tooth to the jaw.* He, however, thinks that they continue to grow for the lifetime of the individual, and that they can distinguish tastes. He cured toothache by the hot wire, or by ramming the affected tooth with cotton dipped in oil of vitriol or aqua fortis. He gives directions for extracting, but says that often three good teeth are taken out without the decayed one being touched. His instrument was called a *pelican.*

16. Scaliger called the ivory of the tooth bone *sui generis*, and compared them to nails.

17. Leeuwenhoek, who put forth by far the most valuable publication of the 17th century, in the Philosophical Transactions for 1678, says, "I have some time since applied a glass (esteemed by several gentlemen who had tried it a very good one) to observe the structure of the teeth and *other bones*, which both to them and myself also then seemed to consist of globules; but since then having drawn out one of my teeth, and for further observation applied better glasses than the former, the same gentlemen with myself agreed from what we plainly saw, that the whole tooth was made up of very small, *straight* and transparent pipes. Six or seven hundred of these pipes put together, I judge exceed not the thickness of one hair of a man's beard. In the teeth of a cow the same pipes appear much bigger, and in those of a haddock somewhat less." He also states that the teeth of the horse and pig are formed in the same way, and gives an account of some substance around the teeth of the calf which is now called *cementum*, and of which he evidently knew the existence but not the use. His statements were so new and extraordinary, that but little attention was paid to them at the time, though future generations live to admire the discoverer of the tubular structure of the teeth.

18. Gagliardi recognised these fibres after calcining the teeth in 1689; and

19. Malpighi, in 1697, named the ivory the "filamentous substance" of the teeth, and stated that it terminated at the root. He affirmed that the cementum on the outside of the fang was a deposit of tartar.

20. Duverney describes the membrane which surrounds the tooth in the fœtal state, and calls it the choroid, which he says leaves the tooth when extruded and forms the periosteum of the socket.

21. Winslow, in 1732, states that the enamel consists of short fibres arranged so as to point inwards at one extremity and outwards at the other.

22. Ludwig, in addition to this says, that the ends of the enamel fibres leave an impression upon the ivory.

23. Bertin recognised the layer of cementum over the fang, but thought that it was enamel; he also described the cavitas pulpæ, and says that it is not empty but filled with a soft substance produced by a lymphatic juice.

24. Delahire, in 1699, stated that the enamel fibres were perpendicular to the triturating surface, and

25. Bronsonnet, in 1737, said that they were horizontal on the sides of the tooth.

26. Herissant, in 1758, discovered the difference between enamel and bone by treating it with dilute muriatic acid, and finding that no cartilage was left behind, and was the first to call its fibres crystalline.

27. We now come to the time of the justly celebrated, but too often quoted, John Hunter, who wrote in 1778, and described his observations with an unequalled clearness and precision. He describes the enamel as fibrous and inorganic. He describes the ivory and calls it bone, but states that when the growing animal is fed on madder, those layers only which are formed during the feeding are coloured, and remain so for the life of the individual, a fact which does not obtain in bone; but without attempting to reconcile these discrepancies, he contents himself by saying that the teeth are *anomalous* bodies, with respect to the circulation. He considered that the roots were covered by a periosteum derived from the alveolus, and thought that it was *prolonged into the dental cavity.* He described the mode of formation of the ivory by successive laminæ, but does not seem to have observed its tubular structure. He was disposed to think the ivory vascular, although *he never could inject it*, because the roots had exostoses and knots formed on them, a change which we now know to take place in the cementum alone. He believed the tooth at the moment of extrusion became a foreign body in relation to the gums, and gave a good account of the formation of the tooth with its pulp, sac, &c. before it was extruded. He described the shedding of the milk teeth, and ascribes it to a law of nature, and denies that their successors have any mechanical agency in effecting this result. He states that the incisors have three centres of ossification, the canine only one, and the molars three or four, and gives his reasons why the molars of the upper jaw must have three fangs. Mr. Hunter's work is yet a standard on many points, but its surgical part cannot remain as authority. He objects to extraction like all his predecessors, but upon a different ground; he says that it is a *weakening cause*, and that the rest of the teeth are weakened by it. Some of his operations must excite a smile at the present day, such as extracting a decayed tooth to boil and replace it; burning the ear with a hot iron, or blistering to cure toothache; and any practical man who reads his directions for extracting, plugging, &c., will soon see that he never could have performed those operations himself. It is a curious fact, that Mr. Hunter had no authority to refer to for his operative part, except Ambrose Paré who wrote 200 years before, which goes to show the very slight improvement in dental surgery for nearly two centuries.

28. We have now brought up the account of the discoveries on the teeth to what may be called the present school of anatomy, and as the results of all their discoveries are given in the body of this work, it will be necessary only to give a resumé of the particular labours of each individual of note since the time of Hunter.

29. The course of modern improvement began with Bichat, who gave a full but somewhat incorrect account of the teeth.

30. Blandin, in his Anatomie du Systeme Dentaire, gives several views of the formation of the ivory and enamel, which cannot be considered correct, although the work contains much valuable information.

31. The principal works which have been published in Great Britain during the present century, are those of Dr. Blake, 1801; Mr. Fox, 1803; and Mr. Bell, 1829.

32. Dr. Blake's work was the best work on the subject at the period it was written, and will be for some time considered as a standard book.

33. Mr. Fox's book was for a long time highly and justly celebrated, and is still sought for as containing much valuable information. He was a skilful practitioner, and at one time a lecturer at Guy's Hospital. Fox, however, considered the teeth as bones, and states that the membranes of the dental germ are both vascular, which proves that he only saw it at one stage of its existence. He also thought the periosteum of the fang and socket a single and common membrane, and supposed decay to arise from *inflammation*, terminating in mortification, and thought that it commenced in the pulp and extended to the ivory, and even goes so far as to recommend drilling the tooth to let out the matter. All these opinions must now be considered as fallacies. His operative surgery was excellent for the period at which he wrote, but is at present almost obsolete. The third of the series was from the pen of Thomas Bell, who succeeded Mr. Fox in the lectureship of Guy's. In this work Mr. Bell has collected all the important facts known at the time, and added many excellent practical observations. He, however, thought the teeth true bone, and thought that they possessed nerves, blood-vessels, and lymphatics like all other bones. He instances, as a proof of his ideas, the red colour of the teeth of persons who have died of strangulation, and explains the shedding of the temporary teeth by calling it a *process of anticipation*. He likewise calls decay, *gangrene*.

34. The French school has furnished some excellent works on the teeth, being chiefly devoted to the anatomy and physiology of those organs, to the almost entire neglect of dental surgery, which is at rather a low ebb on the continent of Europe. We merely notice these works as they appeared, as they may be referred to by the student who desires to possess an unusual amount of information on the subject.

35. In 1812 Baron Cuvier published a splendid work on fossil remains, in which he treats particularly of the structure and formation of the teeth of the elephant, and makes a number of sound and practical remarks on the diseases of the teeth.

36. In 1817 Mr. Serres published his Essai sur l'Anatomie et la Physiologie des Dents, &c., in which he pays particular attention to the teeth in their early stages. As Mr. Serres's work has not been translated, I have taken the following resumé of its contents from Nasmyth, which will give an excellent general idea of its contents.

37. In 1817, M. Serres published a most interesting little work on the Anatomy and Physiology of the Teeth, in which he treats particularly of their organization at an early stage. He says,* "The rudiments of the head, and of all the organs which it contains,

* Essai sur l'Anatomie et la Physiologie des Dents, &c. Paris, 1817, p. 2.

exist almost as soon as the embryo begins to be distinct in the product of conception; the teeth, which are destined to perform the first function in the circle of life, are formed and developed in the interior of the maxillary bones. Preceding anatomists have only ascertained the existence of their germs at a late period of fœtal life; but I thought it necessary to examine them at as early a period as possible." "In the jaws of an embryo of two months, I found the germs of the first incisors and small molars; but I could not find the canine till two months and a half; at three months I discovered the germs, not only of the first, but also of the second dentition, and even that of the wise tooth. These germs are found lodged in membranous folds, which form at this period the gum; those of the first dentition are immediately attached to this fold; those of the second are suspended from it by a pedicle of about two lines long, which alone enables them to be distinguished, together with the yellow colour which they contract by exposure to the air, and which contrasts with the dull white of the gum. At four months I found fibrous partitions separating the incisors; but all the other germs were contiguous to each other. At six months the osseous partition of the incisors was very distinct; that of the small molar was also partly ossified; and the two posterior molars were contained in the same division."

38. He gives a very circumstantial account of the position of these germs, and of the mode of demonstrating them, which consists in detaching them from the internal portion of the alveolar arch. He comes to the conclusion that he has "demonstrated the presence of all the germs in the jaws of the fœtus."

39. He states that he has insulated all the pulps of the first set in the jaws of a fœtus without disturbing either the capsule or the gums, and concludes that the pulp and the capsule "quoiqu' intimement unies sont distinctes l'une de l'autre."

40. He then proceeds to describe the dental membrane, as he calls it, or capsule, enclosing the germs of the teeth, and in the interior of which these bones are developed. This he states to be composed of two plates or layers, "one external and the other internal, distinct not only in their destination, but also in their structure and functions. The external layer, which is fibrous, is opaque and whitish; on one side, it lines the interior of the alveolus, and serves as a periosteum; on the other, it is applied to the external surface of the internal layer. Closely adhering at its inferior part to the dental nerves and vessels, it unites with the cartilage of the gums, and when the tooth has protruded, *it embraces its neck*. It is endowed with a considerable degree of elasticity, and compresses the liquid in which the tooth is plunged: this appears," he says, "to be its use; for if a small opening is made in it, or if a small portion of it be removed, the internal layer, and the liquid which it contains, immediately protrude like a hernial sac through the opening, which proves that compression must be exercised by the external layer."

41. "The internal layer is a very delicate transparent membrane *sui generis*. Bichat affirms that it is serous; but it is entirely vascular, and differs in this respect from that class of membranes: moreover, the fluid which it secretes is mucous as well as serous. It differs from mucous membranes, inasmuch as it has no folicules, and in its natural position may be regarded as a closed sac. I consider it as intermediate between these two orders of

membranes. Externally it is covered, as we have stated, by the external layer, to which it adheres with considerable tenacity, particularly superiorly at the place where it corresponds to the fibro-cartilage of the gums. At the spot where the vessels and nerves penetrate, it detaches itself from the external layer, to which it does not henceforth seem to be united, except by means of small vessels which pass from one layer to the other. Being now isolated from the external layer, it is reflected from below upwards, and envelopes the vessels and nerves as far as the base and the inferior circumference of the pulp, where it is evidently inserted; whether it is continued over the surface of the pulp or not I cannot say; but I have never been able to follow it further than the base, though I have made several careful attempts. It results from this arrangement, 1st, that the sac formed by this layer is closed above by the dental pulp, which forms a kind of lid to it; 2ndly, that this pulp is not enveloped by the membrane, and that it is free in the interior of the sac which it forms, bathed by the fluid which it secretes; 3dly, also that the external membrane is prolonged no further than the place where the vessels and nerves pass in order to penetrate the dental germ, and that it closely adheres to them."

42. Serres next proceeds to give an account of the dental arteries and nerves, and states that although the adult subject possesses only one canal, the fœtus, and even the infant till its sixth or seventh year, (or till that age when the removal of the first tooth commences,) possess two canals for the transmission of vessels: he gives a drawing of this arrangement, which I believe is far from having been established as a constant appearance.

43. "From whatever trunk," says this author, "are derived the vascular branches which penetrate the roots of the teeth, their distribution in the germs is always the same. When they reach the base of the tooth, they pierce the external layer of the membrane, and are continued to the internal layer, on which they ramify to such an extent that this portion of it is rendered entirely vascular in appearance. Beyond the point where the internal layer of the membrane is inserted, several branches penetrate the substance of the dental bulb. I have followed them to the distance of a line from the point where dental ossification takes place. It is to be remarked, that all round the point of insertion of the internal layer into the base of the bulb, the vessels are much more numerous than at any other part, and that they form a vascular circle similar to the anterior and posterior circles of the iris; it is also to be remarked, that this circle, or this reddish areola, which they form on the bulb, descends in proportion as ossification advances, a circumstance which results from the mechanism of the formation of the teeth. It is worthy of notice and admiration, that these vessels, in teeth with a single root, form only a single bundle; in teeth with double roots, they form two bundles; and they are divided into three or four, if the tooth is to have three or four roots."

44. In this work of Serres we find a minute account of the dental nerves, and of a plexus which, he says, is situated beneath the incisors and canines; and this is accompanied by some excellent remarks on the sympathetic pains experienced in the teeth and adjoining parts.

45. He is almost the first who pointed out what he calls the *dental glands*, which he

describes as small sacs or cysts disposed in regular groups spread over the whole cartilaginous substance which forms the gums of the new-born infant. Their function, he considers, consists in lubricating the cartilages of the gums; they also, he thinks, assist the infant in the act of sucking, by retaining the nipple of the mother. He has succeeded in pressing a fluid like serum out of them; and he says that they resemble the Meibomian glands. They are numerous, and the largest are situated on the internal portion of the gum. In the adult subject, Serres maintains that their function is changed to that of secreting the tartar; and he follows up this opinion by observations on that substance, which it is not neccssary here to discuss. We must also pass over in silence his ideas on the physiology of the facial angle at the different periods of life.

46. The second part of his work is devoted to the physiology of the teeth; and he commences it by the general assertion that these organs belong to the osseous system, but are still of a different "*tissue.*" They are composed, he says, of three different substances; viz. enamel which covers the crown, a bony part which constitutes the base, and a soft part which fills up the internal cavity, "*dont la nature ne nous est pas encore bien connue.*" The position and texture of the enamel are well described. He considers that it does not acquire its hardncss and polish till it is exposed to the air; and he combats the opinions of Herissant and Cuvier on this subject. He has never been able to see the follicles of Herissant. This substance has never appeared to him to be fibrous; and he asks why its functions are interrupted when it reaches the fang. After making observations and conjectures on the origin and structure of the enamel, he concludes by confessing that "*il reste beaucoup de choses à faire sur les dents.*"

47. In regard to the osseous part of the tooth, or ivory as it is called, he commences by citing Bichat's opinion that it is fibrous, and dismisses the subject by observing that he has never been able to demonstrate any fibres in it, though he has treated it with acid, and submitted it to the action of fire. He concludes by a series of observations on the difference which he considers to exist between bones and tecth, and these, in order better to illustrate the subject, we will place in parallel columns:—

A BONE	A TOOTH
Passes through a cartilaginous stage.	Passes through no cartilaginous stage, but is a *transudation* from the surface of the pulp.
Has a periosteum.	Has no periosteum.
Is affected by rachitis and the other diseases of the osseous system.	Is not affected by rachitis, or the other diseases of the bones.
Is destroyed by concentrated nitric acid.	Is *not affected* by concentrated nitric acid.
When calcined, leaves a white residue.	When calcined, leaves a bluish residue.
Is destroyed in extra-uterine conception.	Remains untouched in extra-uterine conception.
Is vascular.	Is not vascular.

Finally, bones decay much more quickly after interment than teeth; and the diseases of bones and teeth offer the least possible analogy. Serres relates many curious facts touching the indestructibility of the latter.

48. The pulp he considers as especially formed by the nerve; and in fact, he regards it as a "veritable ganglion," and this opinion he follows up by speculations on its formative functions, and on the fluid which he says surrounds it.

49. He is opposed to instituting any analogy between the pulp and the cartilage of bone; he regards the tooth as an evident secretion from the pulp; and, with respect to the structure of the former, makes an unfortunate assertion which has been signally refuted by the researches of more recent inquirers in this branch of science. His words are:—"A quelques epoques qu'on les considère, on n'aperçoit aucune trace fibreuse, aucune maille celluleuse, qui aient de la parité avec le système osseux."

50. On the eruption of the teeth he makes some very excellent remarks; but, together with all who have hitherto written on the subject, he holds that the capsule is absorbed, or detached from the crown, at the period of extrusion, and that it adheres to the neck, and forms by its external layer the periosteum of the socket, whilst its internal layer adheres to the fang of the tooth.

51. With regard to the order of eruption, he is one of the first who pointed out a circumstance of considerable practical importance, which is, that the first small grinder succeeds next to the lateral incisor, and that the canine appears afterwards, contrary to the generally received opinion that the canine succeeds the lateral incisor; he gives a summary of reasons why the former must be the case.

52. His views on the process of shedding, and on the various theories extant on this subject, are concisely stated; but it does not appear to me that his own hypothesis throws much new light on this process. His explanation resolves itself to the acknowledgment of a "loi primordiale, dont on ne peut donner aucune raison physique," which destroys the partition between the alveoli of the two sets of teeth, and liberates the root of the first tooth, which becomes loose, and falls out on the slightest movement. He does not consider it as a necessary consequence that the fangs of the first set should be absorbed.

53. He discusses at considerable length the order and period of appearance of the second set of teeth, and the contradictory accounts which have been given of this phenomenon; he has evidently studied the subject, and his own ideas on it are narrated with great perspicuity. He concludes his work by a rather lengthy enumeration of supposed examples of third sets of teeth, and of other irregularities.

54. Generally speaking, his pathological remarks, such as those respecting stumps, do not accord with the results of practical observation.

55. The name of Cuvier in connection with the history of the teeth is reiterated in one of his pupils, F. Cuvier, who wrote in 1825 a work replete with valuable information "*On the Teeth* of the *Mammalia considered as Zoological characters.*" This was followed in 1827 by a work from the pen of Rousseau, another of Cuvier's pupils, entitled "*Comparative Anatomy of the Dental System in Man and other Animals.*" He gives a very good account of the teeth, but concludes by saying, "This point of anatomy has not been so well climinated as it is capable of being." He, however, has committed some errors; for instance, he considers that the formation of the enamel precedes that of the ivory, and ascribes the

madder experiment of Hunter to the Baron Cuvier. He also says, that the *cementum* is nothing more than dental tartar, and attempts to account for its formation.

56. Heusinger, in 1822, and Weber in Hildebrand's *Handbuch der Anatomie*, give a very good account of the ivory. But it was reserved for such men as Purkinje,* Muller,† Retzius,‡ Nasmyth§ and Owen,‖ to exhibit and explain their real structure; and for Arnold,¶ Goodsir,** Valentin,†† and Rashkow,‡‡ to give the true history of the tooth in its earlier stages of development, and most splendidly have they accomplished the task. Their works leave nothing to be desired by the student of dental anatomy and physiology, and totally overthrow all the erroneous, unsatisfactory, and contradictory notions which have so long prevailed on the subject of the diseases of the teeth.

* Frœnkel de Structura dentium.
† Archiv. 1836, p. 11.
‡ Poggendorf. Annalen. t. xxxviii. p. 352, tab. iv. fig. 2.
§ Researches on the Development, Structure and Diseases of the Teeth, 1839.
‖ Odontography not yet completed.
¶ 1831.
** On the Pulps and Sacs of the Human Teeth, Edin. Med. and Surg. Journal, Jan. 1839.
†† Entwickelungs geschichte des Menschen.
‡‡ Meletemata circa mammalium dentium evolutionem, 1835.

CHAPTER SECOND.

OF THE MAXILLARY BONES.

57. The maxillary bones, the foundations on which the teeth are based, are two in number, the upper and lower.

OF THE MAXILLA SUPERIOR.

58. The maxilla superior consists of two similar and symmetrical pieces united by a suture in the middle line of the body. Each portion consists of a body and several processes. The body of the bone is hollow, the cavity in it is lined, of the recent state, by the Schneiderian membrane of the *nose*, and communicates with it. It is called the antrum of Highmore (*Antrum Highmorianum*), and is frequently the seat of diseases connected with the teeth. When the two bones are placed together, a process or spine is seen to rise from the body on each side, and form the lateral boundaries of the nose. This is called the nasal spine, and terminates in a rough serrated surface, by which this bone unites with the frontal. The upper half of its anterior edge articulates with the nasal bones forming the bridge of the nose. The roof of the antrum is formed by a thin plate of bone, called the orbitar plate, which is marked by a groove terminating in front in a foramen, called infra-orbitar, and is occupied, in the recent state, by the infra orbitar nerve, which gives branches to the anterior teeth. The front of the bone presents two depressions or fossæ, one called the *incisive fossa*, is just above the roots of the incisor teeth, and the other called *canine fossa*, has the same relation to the cuspid tooth. The under side of the body of the bone, is surrounded at the anterior and outer margin, by the alveolar processes, and forms by its central portion the palate process, which turns up in a median line to articulate firmly with its fellow. On the outer angle between the orbitar plate and the outside of the body, a triangular rough process is formed, called the malar process, which serves to attach this bone to the malar or cheek bone.

OF THE MAXILLA INFERIOR.

59. The maxilla inferior, is a single piece after the age of two years, but, in the fœtal state, is fairly divided in the middle line by a plate of cartilage. Its two halves are precisely alike, and are divided into a body and ramus. The body of the bone is that portion which contains the teeth; its lower margin, which is rounded and thickened, is called the base. On the median line, there are two tubercles called *mental*, one *anterior* not very projecting, and the other *posterior* projecting and bifurcated. This latter gives rise to a muscle of the tongue, the genio-hyo-glossus. On each side of the anterior mental tubercle, the bone has a good deal of squareness in most subjects, and this terminates outwardly, usually just behind the canine tooth, in an opening or foramen called *anterior mental*, which permits a division of the inferior dental artery, vein and nerve to escape, to supply the chin, a name which is strictly applied to the space between these foramina. The summit of the body is formed by the alveolar processes, which overhang its internal surface, on which a depression may be seen which accommodates one of the salivary glands, the *sub-maxillary*. The ramus rises upwards, from the back part of the body, forming an angle at the posterior inferior corner, which varies with the presence or absence of the teeth. In the young subject before the teeth are cut, this angle is obtuse; when the teeth are large and fully developed, it approaches a rectangle, and when, in the progress of old age, they are shed, the angle resumes its character of obtuseness. The adult jaw, with its full angle, may be seen in Plate II. In Plate I. figure 5, the young jaw may be seen in profile, with its obtuse angle, a consequence of the absence of the teeth and alveoli, and in Plate IV. figure 5, the aged jaw is exhibited, which presents the same obtuseness, arising from their loss. The ramus of the jaw terminates upwards in two processes, the posterior one being the condyle, upon which the jaw is hinged, and the anterior, the coronoid process, by which the *temporalis* muscle is attached to the jaw. The condyle is fixed on a narrower portion called the neck, which exhibits a slight roughness in front, into which the *pterygoideus externus* muscle is inserted. The outer side of the ramus is marked by several ridges, and receives over its whole surface the insertion of the masseter muscle. The inner surface of the ramus presents a large opening called the *posterior mental foramen*, which serves to admit to the cavity of the bone the inferior dental artery and nerve. It is bounded by a sharp ridge, from which a shallow groove runs downwards and forwards, occupied by a branch of the nerve called *mylo-hyoid*. The angle on the inner side is very rough for the insertion of the pterygoideus internus muscle.

CHAPTER THIRD.

OF THE ALVEOLI.

60. The alveoli are a row of cells coincident in number and size with the teeth. When the temporary set are in existence, they number ten in each jaw; when the permanent have taken their places, their number is increased to sixteen. Their edges are thin, and the bone composing them is porous, and filled with foramina for the transmission of vessels and the attachment of fibres. When viewed from above, they are seen to form two arches or rather paraboloid curves, which project over the body of the bone outwards in the upper, and inwards in the lower jaw. These are called the *dental arches*. When a tooth is extracted, the corresponding alveolus is absorbed, and the body of the jaw forms on its summit a sharp ridge, which when covered by a callous and hardened gum, serves to masticate most articles of food, though in an imperfect manner. The appearance of the alveoli, as well as the singular condition assumed when they are lost, is shown in Plate I. figures 1, 2, 3 and 4.

CHAPTER FOURTH.

OF THE ARTICULATION OF THE LOWER JAW.

61. The lower jaw is not articulated to the upper, but to the temporal bone. At the root of the zygomatic process of this latter bone a cavity is formed called the *glenoid*, to receive the condyle of the lower maxilla. In front of this cavity there is a slight rising, which is very smooth, and permits the condyle to rise upon it when the mouth is wide open. Both the condyle and the glenoid cavity, including this rising in front, are covered and made perfectly smooth by cartilage to facilitate motion; but the motion of the lower jaw would be very imperfect, if it were not for a beautiful provision in the form of an interposed or inter-articular fibro-cartilage, which divides the articulation into two parts, and permits the full extent of motion demanded by the wants of the maxilla. Two synovial sacs are in consequence of this arrangement furnished to the joint. The bones are held together chiefly by the *external lateral ligament*, a bundle of fibres which passes from the root of the zygoma to the outside of the neck of the condyle of the lower maxilla. (See Plate XIII. figure 1, 3 and figure 4, 3.) There is on the inside another ligament called *internal lateral*, which arises from the base of the cranium at the spinous process of the sphenoid bone, and is inserted into the sharp margin of the posterior mental foramen. Its use, however, is simply to sustain and protect the artery and nerve which enter this foramen.

OF THE MOTIONS OF THE LOWER JAW.

62. The motions of the lower maxilla are four in number. The *first* takes place when the mouth is simply opened and is chiefly produced by the *digastricus* muscle. The *second* occurs when the mouth is shut, and is produced by three powerful muscles, the

temporalis, the *masseter*, and the *pterygoideus internus*, which thus enable the individual to compress his food with great force.

63. The *third* motion is the sliding of the whole jaw forwards, which is produced by the *pterygoideus externus*, assisted in some measure by the obliquity of the insertion of the masseter and internal pterygoid.

64. The *fourth* motion is produced by advancing one condyle at a time so as to produce a lateral grinding motion. These two last motions are the chief agents in the mastication or trituration of the food.

CHAPTER FIFTH.

OF THE MUSCLES OF MASTICATION.

65. The muscles by which the act of mastication is performed, are the Temporalis, the Masseter, the Pterygoideus internus, the Pterygoideus externus, and the Digastricus.

66. The temporalis (Plate XIII. figure 1,) is that beautiful muscle on the side of the head, covered by a fibrous expansion called the temporal fascia or *aponeurosis temporalis.* This aponeurosis is attached to the upper edge of the zygoma, and is extended to the semicircular ridge on the side of the cranium, which may be observed in the first figure in Plate II. This fascia serves the purpose of protecting the muscle from external injury, to which it is much exposed by its position.

67. *Origin.*—The temporalis arises from the whole internal surface of its fascia, from the semicircular ridge above alluded to, (Plate XIII. figure 1, 1, 1,) and from the surfaces of the frontal, parietal, temporal and sphenoidal bones, included between this ridge and the zygomatic process. It arises also from the internal surface of the zygoma itself.

68. *Insertion.*—The fibres from this extended origin, converge and form on the external face of the muscle, a beautiful tendon, which gradually becomes smaller, and is inserted into the coronoid process of the inferior maxilla, (Plate XIII. figure 1, 2,) in such a way that they enclose it and pass for some distance over it, particularly in front.

69. *Use.*—Its use is to close the jaw, and to compress forcibly any substance placed between the teeth, and at the same time draw it backwards.

70. The masseter is found on the outside of the ramus of the jaw, and is blended in its origin with the temporalis, so that it is impossible fairly to separate them. It is immediately under the skin of the face.

71. *Origin.*—It arises (Plate XIII. figure 4, 1, 1) from the malar process of the upper maxillary bone, from the inferior edge of the malar bone, and from the zygomatic process of the temporal bone. As it passes downwards it is seen to be divided into two portions, an *internal* and an *external.* The internal is the smallest and passes directly downwards. The external is larger and passes backwards and downwards.

72. *Insertion.*—The internal portion is inserted into the outer part of the root of the coronoid process. The external is inserted into the angle of the jaw. (Plate XIII. figure

4, 2, 2.) To see the internal part the external must be detached from its origin and turned over.

73. *Use.*—The masseter assists the temporal in closing the jaw, and at the same time aids in drawing it forwards and backwards.

74. The PTERYGOIDEUS INTERNUS is placed on the inside of the ramus of the jaw, and to see it well the jaw must be cut away as in figure 2, Plate XIII.

75. *Origin.*—It arises (Plate XIII. figure 3, 1,) from the outer border of the Eustachian tube, from the internal pterygoid process of the sphenoid bone, and from the greater portion of the fossa pterygoidea.

76. *Insertion.*—It is inserted into the roughness on the inside of the angle of the jaw. (Plate XIII. figure 3, 2.)

77. *Use.*—Its use is to aid the temporal and masseter in closing the jaw, and at the same time draw it forward.

78. The PTERYGOIDEUS EXTERNUS is not so deeply seated as the last, and is seen well in Plate XIII. figures 2 and 3.

79. *Origin.*—It arises (Plate XIII. figure 2, 1, 1,) from the external pterygoid, the spinous and the temporal processes of the sphenoidal bone, and from the tuberosity of the superior maxillary.

80. *Insertion.*—It is inserted into the neck of the inferior maxilla, (Plate XIII. figure 2, 2,) blending with the capsular ligament.

81. *Use.*—The action of this muscle differs when one acts alone or both act simultaneously. In the latter case they draw the jaw powerfully forwards, and in the former they move it from side to side, by advancing the condyles alternately. This is the most efficient muscle in grinding or triturating the food.

82. The DIGASTRICUS is a curious muscle placed under the jaw, and is the antagonist to the four just described. It consists of two bellies, (hence the name from δι, bis, and γαστηρ, venter,) and an intermediate tendon which passes through a loop in the hyoid bone.

83. *Origin.*—Its posterior belly arises from the digastric fossa of the temporal bone, whilst its anterior arises from the inside of the lower maxilla, on each side of the posterior mental tubercle.

84. *Insertion.*—Each belly becomes tendinous, and these two tendons are fused into one, passing through a trochlea or loop attached to the os hyoides, which permits it to play backwards and forwards.

85. *Use.*—Besides several other actions, when the head and os hyoides are fixed by other muscles, it opens the jaw.

86. The 4th figure in Plate XIII. is intended chiefly to exhibit the masseter, but it necessarily includes the muscles of the face, which are named in the explanation of the plate, to which the reader is referred.

PART SECOND.

ANATOMY OF THE TEETH.

CHAPTER FIRST.

MINUTE DESCRIPTION OF THE TEETH.

87. The teeth, intended for the prehension and mastication of the food, are a series of organs belonging to the dermoid or cutaneous system, articulated in a firm and peculiar manner with the bones of the upper and lower jaw. They form two paraboloid curves, called the *dental arches*, of which the upper is the larger, and overlaps the lower in front. Their attachment to the jaw is by a series of cavities, called *alveoli* or alveolar processes, which enclose the roots or fangs of the teeth, by a mode of articulation which has received the name of *gomphosis*. These alveoli come with the teeth, and disappear when they are lost, as may be seen in Plate I. which represents the alveoli of both the upper and lower jaw, as well as the young jaw previous to the eruption of the teeth, and the aged one after they have for a long time disappeared. The teeth are arranged in the dental arches in such a manner, that they are not entirely flat or level on their summits, but form a semi-spiral curve when viewed laterally, as may be seen in Plate II. figure 1.

88. Each tooth is divided *topographically* into the crown, the neck, and the fang. The crown is that portion which projects above the gum in the healthy state of those parts. The neck is seen above the alveolus in the prepared head denuded of the soft parts, but is surrounded and concealed by the gum in the recent state. The fang or root is the part included by the alveolar process, and is only seen when the tooth is dis-articulated. For the purpose of studying the diseases of the teeth and their appropriate remedies, the study of their *structural* division is highly important. This importance is derived from the totally different character of the substances forming a tooth, a difference which is not only recognizable in the perfectly formed tooth, but may be traced to the earliest stages of its growth. For instance, one portion of the tooth, the ivory, may be considered to be a conversion of the pulp (which once had its size and shape) into this substance, or an addition of new matter to the pulp which with it forms the ivory, whereas the enamel is evidently a secretion or crystallization of earthy substances from a solution. Now, in such totally diverse structures, diverse in their origin, in their growth, and in their chemical and mechanical structure when fully formed, no possible analogy can occur in their diseases, and no similarity is to be expected in the action of external agents upon them. Each part of a tooth, therefore, requires a separate consideration, so as to enable the dental surgeon to distinguish their deviations from a normal state, and apply useful and appropriate remedial means.

SECTION FIRST.

STRUCTURAL DIVISION OF A TOOTH.

89. A tooth is composed of four distinct and totally different structures, which I shall describe separately, and in the order of their hardness; *Enamel*, *Ivory*, *Cementum* or *crusta petrosa*, and *Dental pulp*.

SECTION SECOND.

OF THE ENAMEL.

90. The enamel is the dense and pearly white substance which invests and defends the crown of the tooth down to the neck; it varies in its thickness in different parts of the crown, being thickest at the cusps or points of the tooth, and tapering away gradually to the neck, where it terminates in a well defined margin. This variety in its thickness, is exhibited in Plates V. figure 1, and VI. 51 to 55, and is due to the mode of its formation, which commencing by one or more points, spreads gradually over the whole surface, which it ultimately covers. As the point where it commences has more time, it is thickest there. When it commences by more than one point, there is a line formed where the two formations unite; if the union is perfect, the whole surface will be found solid, and no mark will be left to show the position of this line; but in very many cases the union or fusion is not quite perfect, and a deep fissure is left which reaches nearly or quite to the ivory; these fissures afford a nidus for acidifying matter, and are prolific sources of decay. An example of both the perfect and imperfect formations will be found in Plate X.

91. A similar circumstance sometimes occurs on the anterior surface of the incisors near the neck, (see Plate X. figure 12,) and on the crown of the molars, figure 2. These spots should always be looked for in examining the mouth, and if they have a suspicious look, should be subjected to a periodical and close scrutiny. The enamel is composed of an immense number of hexagonal prisms, one end of which rests upon the subjacent ivory. or rather upon a membrane which invests the ivory, and the other forms the triturating or grinding surface of the tooth. These fibres or prisms are not straight, but wave with a gentle undulation; nor are they perfect from end to end, but consist of a series of short prisms, piled one upon the other, like the basaltic columns of the giant's causeway. They

are held together by an intervening membranous animal matter, which is the only residuum found when the enamel is macerated in a dilute mineral acid; and the external surface, when the tooth first appears, has an investment, called by Nasmyth the persistent dental capsule, but which is soon worn off by mastication. The appearance presented by the enamel under the microscope, is well shown in Plate V. figures 1, 2 and 3, the two latter exhibiting a side and an end view of the prisms.

92. The external surface of the enamel is not perfectly smooth, until made so by trituration, but presents a series of transverse ridges which correspond to stages in its formation. The internal surface corresponds with the rough irregular surface of the ivory, an arrangement which increases the firmness of the union between them.

93. It will be seen from the above, that the enamel is almost wholly calcareous, and the following analysis from Berzelius further confirms this statement.

ANALYSIS OF THE ENAMEL.—BERZ.

Phosphate and Fluate of Lime,	88·5
Carbonate of Lime,	8·
Phosphate of Magnesia,	1·5
Free Alkali,	1·
Animal Matter and Water,	1·
	100·0

SECTION THIRD.

OF THE IVORY.

94. This substance, which forms the greater part of the tooth, is usually called the dental bone, but is so totally unlike the osseous tissue, in either its chemical or mechanical character, that the above term is adopted in preference. The ivory is found in the centre of the tooth, being prevented from reaching the surface by an investment of enamel on the body, and of cementum on the neck and fang. It contains a central cavity which varies in its size with the age, and in its shape with the class of the tooth, extending, but diminished in size, to the end of the fang, which it perforates by a minute foramen, which is the sole opening for vascular and nervous supply to the tooth. This cavity contains the dental pulp, which is the formative organ of the ivory. The external surface of the ivory is not smooth but rough, particularly on the body, where it presents a series of irregular conical elevations.

95. When a tooth is broken, the ivory presents a white satiny appearance, which is due to its mieroscopic structure. This consists of an immense number of little pipes or tubuli, which commence with an open end on the surface of the internal or dental cavity, and pursue a course which is gently and regularly undulating, to the surface of the ivory, where they terminate. This undulation is ascribed to a periodical movement of rising and falling in the pulp during the time it is occupied in secreting the ivory. In their course the tubuli branch at first dichotomously, and then by numerous branches, so that it differs in its structure, as it is near the dental cavity or under the enamel; in the former place the tubuli are parallel and not branched, and in the latter consist almost entirely of lateral branches. Their arrangement and mode of branching may be seen in Plate V. figures 1, 6 and 7. The diameter of the tubuli at their commencement is $\frac{1}{4620}$th of an English inch, whilst the diameter of a blood globule averages $\frac{1}{3000}$th, being thus much too large to enter the tubules even if they were entirely open. The parietes of the tubes are white and calcareous, and they contain calcareous matter, which does not entirely fill them, but is broken up into irregular fragments. See Plate V. figure 9. The interspaces between the tubuli, which are wider than the tubuli themselves, consist of a solid and perfectly transparent substance, which is nearly as hard as the tubuli themselves. The white colour of the ivory is due then to the tubuli and their contents, in consequence of the substance between them being transparent, and hence falls short of the pearly whiteness of the enamel, very often presenting a yellowish tinge.

96. When the ivory is macerated in a dilute acid, it is deprived entirely of its earthy ingredients, but loses neither its bulk nor form; its animal matter thus isolated is almost transparent, and has the elasticity and appearance of cartilage. The animal matter is, therefore, in much larger proportion in ivory than in enamel, but still falls far short of bone, as the following analysis will show.

ANALYSIS OF THE HUMAN IVORY.—BERZ.

Phosphate and Fluate of Lime, - - -	64·3
Carbonate of Lime, - - - - -	5·3
Phosphate of Magnesia, - - - - -	1·
Soda and Muriate of Soda, - - - -	1·4
Animal Matter and Water, - - - -	28·
	100·0

This shows 28 per cent. of animal matter in the ivory of the teeth, while bone contains 33 per cent. The Ivory, as previously stated, is secreted by the external surface of the pulp, and once formed undergoes no change, unless attacked by a chemical or mechanical agent. Its vitality is very low, as it possesses neither *circulation* nor *innervation*, being kept in a moist state by the serum furnished it by the surface of the pulp.

SECTION FOURTH.

OF THE CEMENTUM.

97. This substance is the latest in its appearance of the dental constituents, and scarcely exists upon the very young tooth. It is secreted by the periosteal covering of the fang, and covers it and the neck so as to meet the enamel. It is thickest at the point of the fang, where it is liable to an excessive development, and thinnest where it joins the enamel. A kind of cementum is also found at the upper part of the dental cavity in the old tooth, and serves to protect the pulp when the crowns of the teeth become worn down, under which circumstances its formation or secretion is very rapid. The microscopic structure of the external cementum is shown at figure 4, Plate V. and will be found to be very analogous to bone, but wants the vessels, Haversian canals and other constituents of true bone. It also contains less animal matter, and holds an intermediate rank between ivory and bone.

ANALYSIS OF THE CEMENTUM, BY LASSAIGNE.

Animal Matter,	42·18
Phosphate of Lime,	53·84
Carbonate of Lime,	3·98
	100·00

SECTION FIFTH.

OF THE PULP.

98. This, in the perfect tooth, is the remains of a substance which once formed the matrix of the growing tooth, taking the form of its ivory, which is secreted from its surface, and finally diminishing in size, so as just to fill the dental cavity. It is composed of a granular matter, which is invested by an exceedingly delicate membrane or *epithelium*, and

held together by a delicate cellular tissue. It is highly vascular, receiving an arterial branch from the foramen in the end of the fang, and transmitting its effete blood by a vein, which escapes by the same aperture. An idea may be formed of the tenuity of these vessels by stating, that besides the artery and vein, this foramen (just large enough to admit a human hair) also gives passage to a nervous filament, from the fifth pair or trifacial, which forms a multitude of loops in the substance of the pulp, and confers upon it an exquisite sensibility. These loops are represented in Plate V. figure 5. The surface of the pulp keeps the ends of the tubuli of the ivory bathed in a transparent and alkaline halitus or serous fluid, which traverses the tubuli by capillary attraction, and keeps the tooth in a moist and *living* state. This degree of vitality, which is very low, assimilates the condition of the tooth somewhat to that of the crystalline humour of the eye, which seems to have a species of independent vitality of a very low grade, living as it were by the imbibition of the *liquor morgagni*, in which it is bathed. The ivory of the tooth formed by the pulp, depends ever after upon its integrity for existence, except as a foreign substance. Its only connection with the body is by means of the serum filling its tubuli, supplied by the surface of the pulp, and there is but little doubt, that this fluid having reached the under surface of the enamel, continues to pervade it also by means of the delicate membranous matter between its prisms. The cementum possesses minute vessels which penetrate it from the periosteum.

99. If the pulp is destroyed by any means, it decays, and the tubuli absorbing a morbid fluid, the result of its decomposition, gives the tooth a dark blue colour. Sometimes, when this occurs, the tooth becomes painful and requires extraction; and if it is broken, immediately after the operation the decomposing pulp exhales the very quintessence of fœtor. If a tooth be extracted and broken, immediately after death from drowning or strangulation, the pulp will be found almost black from congestion, and sometimes the vessels will be found to be ruptured, and extravasated blood will be discovered between the pulp and the parietes of the dental cavity. The blood globules too large to enter the tubuli, being broken or dissolved, may stain the ivory for some depth. Such cases have been recorded, and have induced the observers to conclude (very erroneously) that ivory was vascular. The position of the pulp in an incisor tooth is shown in Plate V. figure 1.

CHAPTER SECOND.

THE VASCULAR SUPPLY OF THE TEETH.

100. The vascular supply of the teeth is derived from the internal maxillary artery, a branch of the external carotid, an account of which I here subjoin from Wilson.* It will be seen from this, that pressure upon the trunk giving branches to the teeth, will cut off the supply of blood, and may be made the means of arresting hæmorrhage after extraction.

THE INTERNAL MAXILLARY ARTERY.

101. The internal maxillary artery commences in the substance of the parotid gland, opposite the meatus auditorius externus; it passes in the first instance horizontally forwards behind the neck of the lower jaw; next, curves around the lower border of the external pterygoid muscle near its origin, and ascends obliquely forwards upon the outer side of that muscle; it then passes between the two heads of the external pterygoid and enters the pterygo-maxillary fossa. Occasionally it passes between the two pterygoid muscles, without appearing on the outer surface of the external pterygoid. In consideration of its course this artery may be divided into three portions: maxillary, pterygoid, and spheno-maxillary.

102. *Relations.*—The *Maxillary* portion is situated between the ramus of the jaw and the internal lateral ligament, lying parallel with the auricular nerve; the *pterygoid* portion between the external pterygoid muscle, and the masseter and temporal muscle. The *pterygo-maxillary* portion lies between the two heads of the external pterygoid muscle, and in the spheno-maxillary fossa is in relation with Meckel's ganglion.

BRANCHES.

Maxillary portion, { Tympanic, Inferior dental, Arteria meningea magna, Arteria meningea parva.

* Anatomist's Vade-Mecum, p. 277.

Pterygoid portion,	Deep temporal branches, External pterygoid, Internal pterygoid, Masseteric, Buccal.
Pterygo-maxillary portion,	Superior dental, Infra-orbital, Pterygo-palatine, Spheno-palatine, Posterior palatine, Vidian.

103. The *Tympanic* branch is small and not likely to be seen in an ordinary dissection; it is distributed to the temporo-maxillary articulation and meatus, and passes into the tympanum through the fissura Glaseri.

104. The *Inferior dental* descends to the dental foramen, and enters the canal of the lower jaw in company with the dental nerve. Opposite the bicuspid teeth it divides into two branches, one of which is continued onwards within the bone as far as the symphisis, to supply the incisor teeth, while the other escapes with the nerve at the mental foramen, and anastomoses with the inferior labial and submental branch of the facial. It supplies the teeth of the lower jaw, sending small branches along the canals in their roots.

105. The *Arteria meningea magna* ascends behind the temporo-maxillary articulation to the foramen spinosum in the spinous process of the sphenoid bone, and entering the cranium divides into an anterior and a posterior branch. The *anterior branch* crosses the great ala of the sphenoid to the groove or canal in the anterior inferior angle of the parietal bone, and divides into branches, which ramify upon the external surface of the dura mater, and anastomose with corresponding branches from the opposite side. The posterior branch crosses the squamous portion of the temporal bone, to the posterior part of the dura mater and cranium. The branches of the arteria meningea magna are distributed chiefly to the bones of the skull; and in the middle fossa it sends a small branch through the hiatus Fallopii to the facial nerve.

106. The *Meningea parva* is a small branch which ascends to the foramen ovale, and passes into the skull to be distributed to the Casserian ganglion and dura mater. It gives off a small branch to the nasal fossæ and soft palate.

107. The *Muscular branches* are distributed, as their names imply, to the five muscles of the maxillary region; the *temporal* branches are two in number.

108. The *Superior dental* artery is given off from the internal maxillary, just as that vessel is about to make its turn into the spheno-maxillary fossa. It descends upon the tuberosity of the superior maxillary bone, and sends its branches through several small foramina to supply the posterior teeth of the upper jaw, and the antrum. The terminal branches are continued forwards upon the alveolar process, to be distributed to the gums and to the sockets of the teeth.

109. The *Infra-orbital* would appear, from its size, to be the proper continuation of the artery. It runs along the infra-orbital canal with the superior maxillary nerve, sending branches into the orbit and downwards through canals in the bone, to supply the mucous lining of the antrum and the teeth of the upper jaw, and escapes from the infra-orbital foramen. The branch which supplies the incisor teeth, is the *anterior dental artery;* on the face it inosculates with the facial and transverse facial arteries.

110. The *Pterygo-palatine* is a small branch which passes through the pterygo-palatine canal, and supplies the upper part of the pharynx and Eustachian tube.

111. The *Spheno-palatine*, or nasal, enters the superior meatus of the nose through the spheno-palatine foramen in company with the nasal branches of Meckel's ganglion, and divides into two branches; one of which is distributed in the mucous membrane of the septum, while the other supplies the mucous membrane of the lateral wall of the nares, together with the sphenoid and ethmoid cells.

112. The *Posterior-palatine* artery descends along the posterior palatine canal, in company with the posterior palatine branches of Meckel's ganglion, to the posterior palatine foramen; it then curves forwards lying in a groove upon the bone, and is distributed to the palate, while in the posterior palatine canal it sends a small branch backwards, through the small posterior palatine foramen to supply the soft palate, and anteriorly it supplies a branch to the anterior palatine canal, which reaches the nares and inosculates with the branches of the spheno-palatine artery.

113. The *Vidian branch* passes backwards along the pterygoid canal, and is distributed to the sheath of the Vidian nerve, and to the Eustachian tube.

CHAPTER THIRD.

NERVOUS SUPPLY TO THE TEETH.

114. This supply is derived from the fifth pair of nerves or trifacial, which supplies with sensation every part of the face and anterior part of the head. Its relations are such that the most painful affections of the face, included under the name of neuralgia or tic douloureux, are frequently produced by the reflection of some irritation produced in one of the dental pulps. An account of the distribution of its branches follows.

THE TRIFACIAL OR FIFTH NERVE, (TRIGEMINUS.)

115. This nerve is analogous to the spinal nerves in its origin by two roots, from the anterior and posterior columns of the spinal cord, and in the existence of a ganglion on the posterior root. Hence it ranges with the spinal nerves, and is considered as the cranial spinal nerve.

116. It arises by two roots from a tract of yellowish white matter situated in front of the floor of the fourth ventricle and the origin of the auditory nerve, and behind the crus cerebelli. This tract divides inferiorly into two fasciculi which may be traced downwards into the spinal cord, one being continuous with the fibres of the anterior column, the other with the posterior column. Proceeding from this origin the two roots of the nerve pass forward, and issue from the brain upon the anterior part of the crus cerebelli, where they are separated by a slight interval. The anterior is much smaller than the posterior, and the two together constitute the fifth nerve, which in this situation consists of from seventy to a hundred filaments held together by pia mater. The nerve then passes through an oval opening in the border of the tentorium, near to the extremity of the petrous bone, and spreads out into a large semilunar ganglion—the Casserian. (Plate XIV. figure 2.) If the ganglion be turned over, it will be seen that the anterior root lies against its under surface without having any connection with it, and may be followed onwards to the inferior

maxillary nerve. The Casserian ganglion divides into three branches, the ophthalmic, superior maxillary, and inferior maxillary.

117. The Ophthalmic nerve (figure 3,) is a short trunk, being not more than three quarters of an inch in length; it arises from the upper angle of the Casserian ganglion, beneath the dura mater, and passes forwards through the outer wall of the cavernous sinus, lying externally to the other nerves; it divides into three branches. Previously to its division it receives several filaments from the carotid plexus, and gives off a small *recurrent nerve*, that passes backwards with the recurrent branch of the fourth nerve between the two layers of the tentorium to the lining membrane of the lateral sinus.

118. The *Branches* of the ophthalmic nerve are, the

Frontal,
Lachrymal,
Nasal.

119. The *Frontal* nerve (figure 6,) mounts above the levator palpebræ, and runs forward, resting upon that muscle, to the supra-orbital foramen, through which it escapes upon the forehead, and supplies the muscles and integument of that region.

120. It gives off one small branch, the *supra-trochlear*, which passes inwards above the pulley of the superior oblique muscle, and ascends along the middle line of the forehead, distributing filaments to the muscles and integument at the inner angle of the eye and root of the nose.

121. The *Lachrymal* nerve, (figure 7,) the smallest of the three branches of the ophthalmic, receives a filament from the fourth nerve in the cavernous sinus, and passes outwards along the upper border of the external rectus muscle to the lachrymal gland, where it divides into two branches. The superior branch passes over the gland and through a foramen in the malar bone, and is distributed upon the temple and cheek, communicating with the temporo-malar and facial nerves. The inferior branch supplies the lower surface of the gland, and terminates in the integument of the upper lid communicating with the facial nerve.

122. The *Nasal* nerve (figure 8,) passes forwards between the two heads of the external rectus muscle, crosses the optic nerve in company with the ophthalmic artery, and enters the anterior ethmoidal foramen immediately above the internal rectus. It then traverses the upper part of the ethmoid bone to the cribriform plate, and passes downwards through the slit-like opening by the side of the crista galli into the nose, where it divides into two branches—an *internal branch* supplying the mucous membrane, near the anterior openings of the nares; and an *external branch* which passes between the fibro-cartilages, and is distributed to the integument at the extremity of the nose.

123. The *Branches* of the nasal nerve within the orbit are, the ganglionic, ciliary, and infra-trochlear; in the nose it gives off one or two filaments to the anterior ethmoidal cells and frontal sinus. The *ganglionic branch* passes obliquely forwards to the superior angle of the ciliary ganglion, forming its superior or long root. The *ciliary branches* are two or three filaments which are given off by the nasal as it crosses the optic nerve. They pierce

the posterior part of the sclerotic, and pass between that tunic and the choroid to be distributed to the iris. The *infra-trochlear* is given off just as the nerve is about to enter the anterior ethmoidal foramen. It passes along the superior border of the internal rectus to the inner angle of the eye, where it communicates with the supra-trochlear nerve, and supplies the lachrymal sac, caruncula lachrymalis, conjunctiva, and inner angle of the orbit.

124. The Superior maxillary nerve (figure 4,) proceeds from the middle of the Casserian ganglion; it passes forwards through the foramen rotundum, crosses the spheno-maxillary fossa, and enters the canal in the floor of the orbit, along which it runs to the infra-orbital foramen, (figure 10.) Emerging on the face, beneath the levator labii superioris muscle, it divides into a leash of branches, (figure 13,) which are distributed to the muscles and integument of the cheek, forming a plexus with the facial nerve.

125. The *Branches* of the superior maxillary nerve are divisible into three groups:— 1. Those which are given off in the spheno-maxillary fossa. 2. Those in the infra-orbital canal; and 3. Those on the face. They may be thus arranged:—

Spheno-maxillary fossa,	Orbital, Two from Meckel's ganglion, Posterior dental.
Infra-orbital canal, -	Middle dental, Anterior dental.
On the face, - - -	Muscular, Cutaneous.

126. The *Orbital* branch, *Nervus subcutaneus malæ*, (figure 9,) enters the orbit through the spheno-maxillary fissure, and divides into two branches: *malar*, which ascends along the outer wall of the orbit to the lachrymal gland, and communicates with the lachrymal nerve: *temporal*, which passes forwards and divides into two branches: one piercing the malar bone, is distributed to the integument of the cheek, communicating with the facial nerve; the other escaping through the outer wall of the orbit, supplies the temporal muscle and integument in the temporal region, and communicates with the temporal, anterior auricular, and facial nerve.

127. The *Two branches* from Meckel's ganglion ascend from that body to join the nerve, as it crosses the spheno-maxillary fossa.

128. The *Posterior dental* branches (figure 11,) pass through small foramina, in the posterior surface of the superior maxillary bone, and supply the posterior teeth.

129. The *Middle* and *anterior dental* branches (figure 12,) descend to the teeth; the former beneath the lining membrane of the antrum, the latter through distinct canals in the walls of the bone.

130. The *Muscular* and *cutaneous branches* are the terminating filaments of the nerve;

they supply the muscles and integument of the cheek, and form an intricate plexus with branches of the facial nerve.

131. The Inferior maxillary nerve (figure 5,) proceeds from the inferior angle of the Casserian ganglion; it is the largest of the three divisions of the fifth nerve, and is augmented in size by the anterior or motor root, which passes behind the ganglion, and unites with the inferior maxillary as it escapes through the foramen ovale. Emerging at the foramen ovale the nerve divides into two trunks, external and internal, which are separated from each other by the external pterygoid muscle.

132. The *External trunk*, (figure 20,) into which may be traced the whole of the motor root, immediately divides into five branches which are distributed to the muscles of the temporo-maxillary region; they are—

133. The *Masseteric*, which crosses the sigmoid notch with the masseteric artery to the masseter muscle. It sends a small branch to the temporal muscle, and a filament to the temporo-maxillary articulation.

134. *Temporal;* two branches passing between the upper border of the external pterygoid muscle and the temporal bone to the temporal muscle. Two or three filaments from these nerves pierce the temporal fascia, and communicate with the lachrymal, temporo-malar, auricular and facial nerve.

135. *Buccal;* a large branch which pierces the fibres of the external pterygoid, to reach the buccinator muscle. This nerve sends filaments to the temporal and external pterygoid muscle, to the mucous membrane and integument of the cheek, and communicates with the facial nerve.

136. *Internal pterygoid;* a long and slender branch, which passes inwards to the internal pterygoid muscle. This nerve is remarkable from its connection with the otic ganglion, to which it is closely attached.

137. The *Internal trunk* divides into three branches—

Gustatory,
Inferior dental,
Anterior auricular.

138. The Gustatory nerve (figure 17,) descends between the two pterygoid muscles to the side of the tongue, where it becomes flattened, and divides into numerous filaments, which are distributed to the papillæ and mucous membrane.

139. *Relations.*—It lies at first between the external pterygoid muscle and the pharynx, next between the two pterygoid muscles, then between the internal pterygoid and ramus of the jaw, and between the stylo-glossus muscle and the submaxillary gland; lastly, it runs along the side of the tongue, resting upon the hyo-glossus muscle, and covered in by the mylo-hyoideus and mucous membrane.

140. The gustatory nerve, while between the two pterygoid muscles, receives a branch from the inferior dental; lower down it is joined at an acute angle by the chorda tympani (figure 18,) which passes downwards in the sheath of the gustatory to the submaxillary gland, where it unites with the submaxillary ganglion. On the hyo-glossus muscle some

branches of communication are sent to the hypoglossal, and in the course of the nerve several small branches to the mucous membrane of the fauces, and to the tonsils, and numerous filaments to the submaxillary gland.

141. The Inferior dental nerve (figure 15,) passes downwards with the inferior dental artery, at first between the two pterygoid muscles, and then between the internal lateral ligament and the ramus of the lower jaw, to the dental foramen. It then runs along the canal in the inferior maxillary bone, distributing branches to the teeth, and divides into two branches, incisive and mental. The *incisive* branch passes forwards, to supply the incisive teeth: and the *mental* branch (figure 16,) escapes through the mental foramen, to be distributed to the muscles and integument of the chin, and to communicate with the facial nerve.

142. It gives off but one branch, the *mylo-hyoidean*, which leaves the nerve just as it is about to enter the dental foramen. This branch pierces the insertion of the internal lateral ligament, and descends along a groove in the bone to the superior surface of the mylo-hyoid muscle, to which it is distributed.

143. The Anterior auricular nerve (figure 19,) passes directly backwards behind the articulation of the lower jaw, against which it rests. In this situation it divides into two branches, which reunite, and form a kind of plexus. From the plexus two branches are given off—ascending and descending. The *superficial temporal branch* sends a considerable branch of communication to the facial nerve, and then ascends in front of the ear to the temporal region, upon which it is distributed in company with the branches of the temporal artery. In its course it sends filaments to the temporo-maxillary articulation, to the pinna and meatus of the ear, and to the integument in the temporal region. It communicates on the temple with branches of the facial, supra-orbital, lachrymal, and temporo-malar nerve. The *descending branch* enters the parotid gland, to which it sends numerous branches; it communicates with the inferior dental and auricularis magnus nerve, and supplies the external ear and the temporo-maxillary articulation.

CHAPTER FOURTH.

ARTICULATION OF THE TEETH.

144. It has been before stated, that the teeth were articulated with the jaws by means of the gomphosis articulation; a mode of articulation which resembles the union of a nail with the wood into which it is driven. It yet remains to be stated what tissues intervene between the fang and its corresponding alveolus.

145. The alveolus is lined by the periosteum, which is a fibrous membrane, continuous with the periosteum of the jaw. The fang has a similar covering investing it very closely, and of a thinner and denser structure than that of the alveolar cavity. These two membranes adhere to each other by a multitude of fibres, all of which must be torn in the act of extraction, and which may be beautifully demonstrated by dissecting the jaw of an ox or horse. Some of these fibres are minute arteries and veins, whilst others are fibrous or ligamentous in their character. These last exist in considerable numbers exactly at the margin of the alveolus, and unite it closely with the neck of the tooth. This attachment is so strong in the bicuspids and molars, particularly where the latter are contiguous, that it presents a serious obstacle to extraction unless previously divided.* This kind of articulation permits a slight degree of motion, when the tooth is grasped firmly by the thumb and finger and moved. The absence or presence of pain when this manœuvre is executed, furnishes us with a test of the existence of inflammation in the socket, for in the healthy condition this movement is absolutely without a painful sensation. The arrangement also permits motion when the teeth are employed in mastication; for if two molars which press against each other be examined, the enamel at the point of contact will be found considerably worn.

* I described these latter fibres some years ago in the American Journal of Medical Sciences, and thought them worthy of the name *ligamentum dentis;* but their very existence was scouted at by sundry wiseacres, who, however, contented themselves with the simple assertion that *they* could not find them.

CHAPTER FIFTH.

NUMBER AND CLASSES OF THE TEETH.

146. The human species, in common with other mammals, possesses two sets of teeth, one destined to serve the purposes of childhood, and to fill the yet unexpanded jaw, called the infantile, milk or temporary teeth. This set consists of twenty individuals, ten in each jaw, and lasts from about the sixth month of life to the term included between the sixth and twelfth year; when they are completely replaced by a similar number forming a part of the second or permanent set. This latter set, thirty-two in number, usually endures for the life of the individual, subject of course to the effects of decay, and replaced in a few rare instances by a third set. Cases of the occurrence of this third dentition are recorded by Bacon, Joubert, Sennert, John Hunter, Good, and Mentzelius;* it is usually composed of *twenty* teeth. Both the temporary and permanent sets are composed of several classes, three of which are common to both, and one peculiar to the permanent set. These classes are designated by the names *incisors*, *cuspid*, *bicuspid*, and *molars*. The temporary set consists of eight incisors, four in each jaw, four cuspid, and eight molars, *twenty* in all. The permanent set includes another class, and consists of eight incisors, four cuspid, eight bicuspid, and twelve molars, *thirty-two* in all. The latter of these are displayed in Plate II. and the former in Plate III., and both sets may be seen separately in Plate VI.

SECTION FIRST.

OF THE INCISORS OR INCISORES.

147. These teeth, named from *in* into, and *scindo* to cut, are so called from their shape, which resembles a chisel. The anterior part of the crown is convex, usually marked with two or three shallow longitudinal grooves, and brought to a thin edge, which when first

* A case is also recorded in Harris's Dental Art as occurring in the practice of Dr. M'Cabe, of Virginia.

cut presents several points; soon worn off by mastication; their sides are rounded, and the posterior surface concavely bevelled off to the edge, and not uncommonly marked by two or three furrows, deeper than those on the anterior surface. The fang is simple and conoidal, terminating in a moderately sharp point. The incisors of the upper jaw are larger and broader than those of the lower, and the pair next the median line are the largest. Their fangs are terete or rounded, and possess roomy alveoli. Those of the lower jaw are equally deep antero-posteriorly but much narrower, the pair next the median line being the smallest; their fangs are much flattened laterally, and commonly marked by a shallow groove. They are much crowded, and their alveolar partitions thin. The incisors of the temporary set differ from their analogues of the permanent, in being wider and shorter, and like all the other members of the former set, are less perfectly formed and more liable to decay than those of the latter. (See Plates II., III. and VII., and also Plate VI. figures 1, 2, 9, 10, 17, 18, 25 and 26.

SECTION SECOND.

OF THE CUSPIDS OR CUSPIDATI.

148. This set, called also Canines from their resemblance to dog's teeth, (*canis*, a dog,) receive their name from *cuspis*, a spear, in consequence of their termination in a point. The upper pair are frequently called the *eye*, and the lower the *stomach* teeth. The *cuspidati* present a larger and firmer crown than the incisors, which terminates in a sharp point. Their anterior face is very convex, and the posterior is either slightly so or nearly straight, being, however, much bevelled off towards the point. Their fangs are round or slightly oval, and usually curved inwards, their length being very considerable compared with the other classes, and correspondingly large. There is but little difference in the members of the two sets, except in size. See Plate VI. figures 3, 11, 19 and 27.

SECTION THIRD.

OF THE BICUSPIDS OR BICUSPIDATI.

149. These teeth, holding an intermediate position between the *cuspidati* and the *molars*, are so called from *bis* twice, and *cuspis*, and are peculiar to the permanent set. They are

sometimes called the small molars or small grinders, and replace the molars of the temporary set, having the peculiarity of being both smaller and narrower than those which they replace. The summit of their crowns is neither pointed nor cutting, but flat with the exception of two dull conical points, one on the inside of the other. The outer and inner faces of the crown are convex, whilst the sides are flattened and sometimes slightly concave. Their fangs are usually conoidal, flattened at the sides, and give strong evidence of consisting of two fangs fused into one. This fusion does not always occur, and two fangs are found either entirely or partially distinct. The dental cavity, which in the former classes of teeth, viz. the incisors and cuspidati was simple, is now found to be compound, and not unfrequently to have a double supply of vascular and nervous influence. Of the two, the anterior tooth or that next the cuspid is the smallest in the crown, but has a larger and longer fang. (See Plate VI. figures 4, 5, 12, 13, 20, 21, 28, 29 and 56.)

SECTION FOURTH.

OF THE MOLARS OR MOLARES.

150. The *molares* or grinders derive their name from *molo*, to grind, a name expressive of their use. They present a crown whose summit is quadrangular and flat, with the exception of four or five cusps or obtuse points, which are found upon them, and indicate their origin from as many germs.

151. In the interspaces between the cusps are found several deep fissures, arising from an imperfect condition of the enamel; their appearance is well defined in Plate X. figure 2. As the enamel is deposited first on the points of the cusps, and commences on all of them simultaneously, these fissures are formed by the fusion of the several points into one. When the molars are very perfect in their organization, they do not exist, but the fusion is complete over the whole surface. In this case decay rarely attacks the crown, whereas, the fissures in the opposite condition affording a lodgement for acescent food, are most favourably situated for the commencement of this process. The outer and inner, as well as the lateral surfaces are flat, with the exception of a broad and shallow groove, which is continuous with the depression between the cusps on the corners of the summit. The fangs of the molares differ in the two jaws; in the lower the four fangs are fused into two, one of which is placed in front of the other in the alveolar cavity; in the upper jaw, on the contrary, only one pair of fangs are fused together, namely, the inner, the two outer ones remaining separate. The molars of the lower jaw, therefore, present two flat and grooved fangs, and those of the upper three, one of which is evidently double, and both larger and longer than either of the others. These latter teeth are placed in the jaw like

the key-stone of an arch, the two separate fangs on the exterior circumference and the other on the interior. The above is the general rule, to which there are some exceptions, such as the molares of each jaw having four or five separate fangs; a view of the regular arrangement, and of the deviations from it, are given in Plate VI. figures 6, 7, 8, 14, 15, 16, 22, 23, 24, 30, 31, 32, and from 42 to 50. The first molar or that nearest the bicuspid, is the largest of the class, and as elsewhere remarked, is the most curious of the teeth. Developed in the primitive dental groove, along with the temporary teeth, and the first of the permanent set to make its appearance, it becomes sometimes the most enduring of any, although in general its decay is premature. The last molars are commonly called the wisdom teeth (*dentes sapientæ*), in consequence of their appearing late in life, when the individual is supposed to have arrived at years of discretion. They differ in several points from the others, their crown being smaller and more rounded, and if the fangs are not fused into a single irregular and short conical root, they are bent and distorted in such a manner as to render their extraction a matter of considerable difficulty. This arises from a want of room for their development. The difference between the molares of the permanent and temporary sets, merely arises from a variety of size and a less perfect organization of the latter.

152. The dental cavity in the molares is large and quadrangular, and is supplied by as many arteries and nerves as there are roots or fangs. When the tooth is young, it approaches the grinding surface of the crown very nearly, but as the tooth advances in age a considerable secretion of cementum diminishes the cavity, and at the same time causes it to recede from the surface. If the tooth wears by use, this secretion is more rapid so as to defend the pulp from exposure. See Plate VI. figures 51 to 56.

PART THIRD.

PHYSIOLOGY OF THE TEETH.

CHAPTER FIRST.

ORIGIN AND DEVELOPMENT.

153. This point in the physiology of the teeth has been so closely examined and fully described by Mr. Goodsir, in the Edinburgh Medical and Surgical Journal, January, 1839, that I have thought proper to give the following transcript of his researches from Wilson's Anatomist's Vade-Mecum, and accompany it with Mr. Goodsir's original sketches, which will be found in Plate VII.

154. The inquiries of Mr. Goodsir commenced as early as the sixth week after conception, in an embryo, which measured seven lines and a half in length and weighed fifteen grains. At this early period each jaw presents two semicircular folds around its circumference; the most external is the true lip; the internal, the rudiment of the palate; and between these is a deep groove, lined by the common mucous membrane of the mouth. A little later a ridge is developed from the floor of this groove in a direction from behind forwards, this is the rudiment of the external alveolus; and the arrangement of the appearances from without inwards at this period is the following:—Most externally, and forming the boundary of the mouth, is the *lip;* next we find a *deep groove*, which separates the lip from the future jaw; then comes the *external alveolar ridge;* fourthly, another groove, in which the germs of the teeth are developed, the *primitive dental groove;* fifthly, a rudiment of the *internal alveolar ridge;* and, sixthly, the rudiment of the *future palate* bounding the whole internally. At the seventh week the germ of the first deciduous molar of the upper jaw has made its appearance, in the form of a "simple, free, granular papilla" of the mucous membrane, projecting from the floor of the primitive dental groove; at the eighth week, the papilla of the canine tooth is developed; at the ninth week the papillæ of four incisors (the middle preceding the lateral) appear; and at the tenth week the papilla of the second molar is seen behind the anterior molar in the primitive dental groove. So that at this early period, the tenth week, the papillæ or germs of the whole of the ten deciduous teeth of the upper jaw are quite distinct. Those of the lower jaw are a little more tardy; the papilla of the first molar is merely a slight bulging at the seventh week, and the tenth papilla is not apparent until the eleventh week.

155. From about the eighth week the primitive dental groove becomes contracted before and behind the first deciduous molar, and laminæ of the mucous membrane are

developed around the other papillæ, which increase in growth and enclose the papillæ in follicles with open mouths. At the tenth week the follicle of the first molar is completed, then that of the canine; during the eleventh and twelfth weeks the follicles of the incisors succeed, and at the thirteenth week the follicle of the posterior deciduous molar.

156. During the thirteenth week the papillæ undergo an alteration of form, and assume the shape of the teeth they are intended to represent. And at the same time small membranous processes are developed from the mouths of the follicles; these processes are intended to serve the purpose of opercula to the follicles, and they correspond in shape with the form of the crowns of their appertaining teeth. To the follicles of the incisor teeth there are two opercula; to the canine, three, and to the molars a number relative to the number of their tubercles, either four or five. During the fourteenth and fifteenth weeks the opercula have completely closed the follicles, so as to convert them into *dental sacs*, and at the same time the papillæ have become *pulps*.

157. The deep portion of the primitive dental groove, viz. that which contains the dental sacs of the deciduous teeth, being thus closed in, the remaining portion, that which is nearer the surface of the gum, is still left open, and to this Mr. Goodsir has given the title of *secondary dental groove;* as it serves for the development of all the permanent teeth, with the exception of the anterior molars. During the fourteenth and fifteenth weeks small lunated inflections of the mucous membrane are formed, immediately to the inner side of the closing opercula of the deciduous dental follicles, commencing behind the incisors and proceeding onwards through the rest; these are the rudiments of the follicles or *cavities of reserve* of the four permanent incisors, two permanent canines, and the four bicuspides. As the secondary dental groove gradually closes, these follicular inflections of the mucous membrane are converted into closed *cavities of reserve*, which recede from the surface of the gum and lie immediately to the inner side and in close contact with the dental sacs of the deciduous teeth, being enclosed in their submucous cellular tissue. At about the fifth month the anterior of these cavities of reserve dilate at their distal extremities, and a fold or papilla projects into their fundus, constituting the rudiment of the germ of the permanent tooth; at the same time two small opercular folds are produced at their proximal or small extremities, and convert them into true dental sacs.

158. During the fifth month the posterior part of the primitive dental groove behind the sac of the last deciduous tooth has remained open, and in it has developed the papilla and follicle of the first permanent molar. Upon the closure of this follicle by its opercula, the secondary dental groove upon the summit of its crown forms a large cavity of reserve, lying in contact with the dental sac upon the one side and with the gum upon the superficial side. At this period the deciduous teeth, and the sacs of the ten anterior permanent teeth, increase so much in size, without a corresponding lengthening of the jaws, that the first permanent molars are gradually pressed backwards and upwards into the maxillary tuberosity in the upper jaw, and into the base of the coronoid process of the lower jaw; a position which they occupy at the eighth and ninth months of fœtal life. In the infant of seven or eight months the jaws have grown in length, and the first permanent molar

returns to its proper position in the dental range. The cavity of reserve, which had been previously elongated by the upward movement of the first permanent molar, now dilates into the cavity which that tooth has just quitted; a papilla is developed from its fundus, the cavity becomes constricted, and the dental sac of the second molar tooth is formed, still leaving a portion of the great cavity of reserve in connection with the superficial side of the sac. As the jaws continue to grow in length, the second permanent dental sac descends from its elevated position and advances forwards into the dental range, following the same curve with the first permanent molar. The remainder of the cavity of reserve, already lengthened backwards by the previous position of the second molar, again dilates for the last time, developes a papilla and sac in the same manner with the preceding, and forms the third permanent molar or wisdom tooth, which, at the age of nineteen or twenty, upon the increased growth of the jaw, follows the course of the first and second molars into the dental range.

159. From a consideration of the foregoing phenomena, Mr. Goodsir has divided the process of dentition into three natural stages:—1. follicular; 2. saccular; 3. eruptive. The first, or *follicular stage*, he makes to include all the changes which take place from the first appearance of the dental groove and papillæ to the closure of their follicles; occupying a period which extends from the sixth week to the fourth or fifth month of intra-uterine existence. The second, or *saccular stage*, comprises the period when the follicles are shut sacs, and the included papillæ pulps; it commences at the fourth and fifth months of intra-uterine existence, and terminates for the median incisors, at the seventh or eighth month of infantile life, and for the wisdom teeth at about the twenty-first year. The third, or *eruptive stage*, includes the completion of the teeth, the eruption and shedding of the temporary set, the eruption of the permanent, and the necessary changes in the alveolar processes. It extends from the seventh month till the twenty-first year.

160. "The *anterior permanent molar*," says Mr. Goodsir, "is the most remarkable tooth in man, as it forms a transition between the milk and the permanent set." If considered anatomically, *i. e.* in its development from the primitive dental groove, by a papilla and follicle, "it is decidedly a milk tooth;" if physiologically, "as the most efficient grinder in the adult mouth, we must consider it a permanent tooth." "It is a curious circumstance, and one which will readily suggest itself to the surgeon, that laying out of view the wisdom teeth, which sometimes decay at an early period from other causes, the anterior molars are the permanent teeth which most frequently give way first, and in the most symmetrical manner and at the same time, and frequently before the milk set."

161. The various changes here detailed are exhibited in Plate VII. which has been taken from Mr. Goodsir's original paper, the only difference being, that they have been enlarged to make the succession of changes more evident. The plate is fully described in the accompanying reference, to which the reader is referred.

GROWTH OF THE TEETH.

162. Immediately that the dental follicles have been closed by their opercula, the pulps become moulded into the form of the future teeth; and the bases of the molars divided into two or three portions, representing the future fangs. The dental sac is composed of two layers, an internal or vascular layer, which was originally a part of the mucous surface of the mouth, and a cellulo-fibrous layer, analogous to the corium of the mucous membrane.* These membranes enclose a yellow fluid which is more consistent than serum. Upon the formation of this sac by the closure of the follicle, the mucous membrane resembles a serous membrane in being a shut sac, and may be considered as consisting of a tunica propria, which invests the pulp; and a tunica reflexa, which is adherent by its outer surface with the structures in the jaw, and by the inner surface is free, being separated from the pulp by an intervening cavity. As soon as the moulding of the pulp has commenced, this cavity increases and becomes filled with a gelatinous granular substance, the *enamel organ*,† which is adherent to the whole internal surface of the tunica reflexa, but not to the tunica propria and pulp. At the same period, viz. during the fourth or fifth month, a thin lamina of ivory is secreted by the pulp, and deposited upon its most prominent point: if the tooth be incisor or canine, the secreted layer has the form of a small hollow cone; if molar, there will be four or five small cones corresponding with the number of tubercles on its crown. These cones are united by the secretion of additional layers, the pulp becomes gradually surrounded and diminishes in size, depositing fresh layers during its retreat into the jaws until the entire tooth with its fangs is completed, and the small cavitas pulpæ of the perfect tooth alone remains, communicating through the opening in the apex of each fang with the dental vessels and nerves. The number of roots appears to depend upon the number of nervous filaments sent to each pulp. When the secretion of the ivory has commenced, the enamel organ becomes transformed into a laminated tissue, corresponding with the direction of the fibres of the enamel, and the crystalline substance of the enamel is secreted into its meshes by the vascular lining of the sac. It will thus be seen that the ivory and enamel are formed in different directions, the former from the surface to the centre, and the latter from the centre toward the surface of the crown.

* At an early stage of the existence of the double sac, both the internal and external membranes are vascular, and some anatomists have described them as such, thus presenting a discrepancy between their account and that of John Hunter, who described the sacs in their perfect state.

† The enamel organ at first presents itself in the form of a soft pad at the upper part of the dental sac. Its surface is rough, and it consists of granules which soon assume a polygonal shape, and are united by fibres. The pad, as soon as the surface of the pulp begins to secrete ivory, comes in contact with it and adheres, moulding itself gradually to it until the whole crown is formed, when it covers it closely like a hood, reaching as far as the neck of the tooth. The surface next the ivory is soon converted into elongated cellules, which form the first row of crystals of enamel. The second row is added to the first, and so on till the whole thickness of the enamel is formed.

163. The *cementum* appears to be formed at a later period of life, either by a deposition of osseous substance by that portion of the dental sac which continues to enclose the fang, and acts as its periosteum, or by the conversion of that membrane itself into bone; the former supposition is the more probable.

164. The secretion of ivory commences in the first permanent molar previously to birth.

ERUPTION OF THE TEETH.

165. When the crown of the tooth has been formed and coated with enamel, and the fang has grown to the bottom of its socket by the progressive lengthening of the pulp, the deposition of ivory, and the adhesion of the ivory to the contiguous portion of the sac, the pressure of the socket causes the reflected portion of the sac and the edge of the tooth to approach, and the latter to pass through the gum. The sac has thereby resumed* its original follicular condition, and has become continuous with the mucous membrane of the mouth. The opened sac now begins to shorten more rapidly than the fang lengthens, and the tooth is quickly drawn upwards by the contraction, leaving a space between the extremity of the unfinished root and the bottom of the socket, in which the growth and completion of the fang is more speedily effected.

166. During the changes which have here been described as taking place among the dental sacs contained within the jaws, the septa between the sacs, which at first were composed of spongy tissue, soon became fibrous, and were afterwards formed of bone, which was developed from the surface and proceeded by degrees more deeply into the jaws, to constitute the alveoli. The sacs of the ten anterior permanent teeth, at first enclosed in the sub-mucous cellular tissue of the deciduous dental sacs, and received during their growth into crypts situated behind the deciduous teeth advanced by degrees beneath the fangs of those teeth, and became separated from them by distinct osseous alveoli. The necks of the sacs of the permanent teeth, by which they originally communicated with the mucous lining of the secondary groove, still exist, in the form of minute obliterated cords, separated from the deciduous teeth by their alveolus, but communicating through a minute osseous canal with the fibrous tissue of the palate, immediately behind the corresponding deciduous teeth. "These cords and foramina are not obliterated in the child," says Mr. Goodsir, "either because the cords are to become useful as '*gubernacula*' and the canals as '*itinera dentium;*' or, much more probably, in virtue of a law, which appears to be a general one in the development of animal bodies, viz. *that parts, or organs, which have once acted an important part, however atrophied they may afterwards become, yet never altogether disappear, so long as they do not interfere with other parts or functions.*"

167. Several views of the sacs, gubernacula, &c., are given in Plate VII. figures 32 to 41.

* Mr. Nasmyth is of opinion that it is "by a process of absorption, and not of disruption, that the tooth is emancipated." Medico-Chirurgical Transactions. 1839.

ORDER OF THE APPEARANCE OF THE TEMPORARY TEETH.

168. The temporary teeth make their appearance in the following order:—

First,	The central incisors of the lower jaw.
Second,	The central incisors of the upper jaw.
Third,	The lateral incisors of the upper jaw.
Fourth,	The lateral incisors of the lower jaw.
Fifth,	The first molars of the lower jaw.
Sixth,	The first molars of the upper jaw.
Seventh,	The cuspid or canine of the upper jaw.
Eighth,	The cuspid or canine of the lower jaw.
Ninth,	The second molars of the lower jaw.
Tenth,	The second molars of the upper jaw.

169. The time of their eruption is as follows:—

The central incisors, from the sixth to the seventh month.
The lateral incisors, from the eighth to the ninth month.
The first molars at the twelfth month.
The canines at the eighteenth month.
The second molars at the twenty-fourth month.

CHAPTER SECOND.

SUCCESSION OF THE TEETH.

170. When the temporary teeth have completed their eruption, the permanent exist in the jaws in a regular juxtaposition with them, which however varies with the class. If the young jaws be examined at this time, a minute opening will be found immediately behind each of the incisor teeth, but removed about a line from the edge of the alveolus. These apertures are called *itinera dentium*, or the road of the teeth, because they indicate the spot where the permanent incisor will make its appearance. This aperture is occupied in the recent subject, by a fibrous or ligamentous cord, which connects the sac of the permanent incisor with the neck of its temporary companion. This cord is called *gubernaculum dentis*. Similar foramina will be found behind the canine or cuspid teeth, but they are much nearer being formed in fact within the edge of the alveolus, which also contain gubernacula. The *itinera dentium* are figured in Plate IV., and the gubernacula and their mode of connection may be seen in Plate VII. figures 39, 40 and 41. In the case of the molars of the child, and their successors the bicuspid, the arrangement is different; the gubernacular connection is to the under part of the body between the fangs; they rise in the same place, so that the necessity for a separate *iter* does not exist. An admirable front and lateral view of a temporary set, with the unfinished permanent ones in their cavities, will be found in Plate VIII.

171. The cause of the shedding of the temporary teeth has been much discussed, but it depends chiefly upon the death of the tooth, produced by the loss of its arterial supply. When the permanent tooth impinges upon the end of the fang of its predecessor, it cuts off its supply of arterial blood, thus producing its death. This is followed by an absorption of the end of the fang to a greater or less extent, rendering it loose and easily removed. This absorption does not occur in the tooth, as it is now an extraneous body, but is performed by the surrounding tissues, the actions of which are exalted by the irritation of the rising permanent tooth. During the existence of the temporary set, each side of the lower jaw possesses three arteries, one to supply the bone, a second to supply the germs of the permanent teeth, and a third for the temporary set. This arrangement, which has its analogue in the upper maxilla, is figured in Plate VIII. figures 5 and 6.

172. When the temporary teeth are shed, this last artery is entirely obliterated, and ceases to exist as a vessel.

173. The dental arches are of small extent during the existence of the temporary or infantile teeth, and expand to nearly double their depth after the completion of the permanent dentition. Each permanent tooth being replaced by a corresponding permanent one, the arches are only lengthened by the additional teeth, whilst they are expanded laterally. This is well shown in Plate IV., where the line drawn across both sets indicates the cause and amount of the lengthening of the dental arches.

ORDER OF APPEARANCE OF THE PERMANENT TEETH.

174. These teeth make their appearance in the following order:—

First, The first molars of the lower jaw.
Second, The first molars of the upper jaw.
Third, The central incisors of the lower jaw.
Fourth, The central incisors of the upper jaw.
Fifth, The lateral incisors of the upper jaw.
Sixth, The lateral incisors of the lower jaw.
Seventh, The first bicuspides.
Eighth, The second bicuspides.
Ninth, The cuspid or canine teeth.
Tenth, The second molars.
Eleventh, The third molars.

175. The times of their appearance is as follows:—

First molares, sixth year.
Two middle incisors, seventh year,
Two lateral incisors, eighth year.
First bicuspids, ninth year.
Second bicuspids, tenth year.
Canines, eleventh to twelfth year.
Second molars, twelfth to thirteenth year.
Third molars, seventeenth to twenty-first year.

THE THIRD SET OF TEETH.

176. In the rare cases in which the third set make their appearance, it is recorded, that they are somewhat irregular, usually twenty in number, and make their appearance from the seventieth to the one hundred and twentieth year of life.

PART FOURTH.

DENTAL PATHOLOGY, SURGERY, AND THERAPEUTICS.

CHAPTER FIRST.

DISEASES OF THE ENAMEL.

177. The diseases of the teeth are best divided according to the tissue affected, commencing with the hardest; thus we have the diseases of the enamel, the ivory, the cementum, the pulp, and finally those which implicate the tooth as a whole.

178. As the enamel is a secretion, and consists of ninety-nine per cent. of mineral substances, it is self-evident that it cannot become the seat of disease in the proper sense of the word. But it is found to present such an appearance, and although the name is inappropriate, it was thought better to retain it. All its apparent diseases arise, either from external causes, or from an imperfect formation of this important coating in the saccular stage of the growing tooth.

SECTION FIRST.

DENUDATION OR WEARING OF THE ENAMEL.

179. Causes.—The causes of denudation are mechanical, and may be summed up in a few words. It may arise from mastication of gritty substances, a movement of the jaws in the act *peculiar to the individual* in whom the denudation occurs, usually wearing off the summits of the whole set, and arising from the great size and strength of the pterygoid muscles, (see paragraph 74,) the use of coarse dentifrices, and hard brushes, smoking pipe in the same place, friction of two contiguous teeth, and the use of the file.

180. Treatment.—This frequently cannot be applied; the mischief is done, and the lost enamel cannot be replaced; but if discovered in time, it may be prevented by altering the relative position of the rubbing teeth, or in any way removing the cause.

SECTION SECOND.

CRACKING OF THE ENAMEL.

181. This most commonly arises from the sudden application of cold after heat, which producing a rapid contraction of the surface, causes it thereby to become too small for the crown which it covers, and to give way at the weakest point.

182. Treatment.—If it produces no inconvenience it should not be meddled with; if, however, it gives rise to tenderness, it may be sufficiently open to afford a lodgement for foreign matter, and be the cause of decay. It might be well to dry the surface of the tooth, and then keep it moist for a few seconds with a solution of mastic in alcohol, which would enter the crack by capillary attraction, and coagulating at the bottom, defend for a long time the ivory from the action of acid fluids.

SECTION THIRD.

FRACTURE OF THE ENAMEL.

183. This is only a severe form of the former accident, and most usually extends to the ivory. Its causes are also mechanical, such as cracking hard substances, blows, &c.

184. Treatment.—When the edge of the enamel is broken from an incisor, the file must be used to remedy as far as possible the deformity, and prevent any injury to the ivory. The treatment recommended for cracking may in some cases be useful here.

SECTION FOURTH.

EROSION AND DECOMPOSITION OF THE ENAMEL.

185. Erosion of the enamel derives its name from the appearance presented by it. It looks as if the surface of the tooth had been irregularly eaten into by an insect. In

decomposition, this appearance is accompanied with a moist whitish substance, which occupies the bottom of the shallow cavity formed.

186. The causes here are either vital or chemical. *Erosion* arises from an imperfect formation of the enamel, and shows itself in the form of holes, irregular depressions, and in grooves or ridges, which extend transversely across a tooth, and indicate the state of health of the individual during the formation of that particular zone or band of the enamel. Sometimes two or three zones are found on each tooth, being caused by three periods of defective health. Several varieties of this phenomenon are shown at Plate IX.

187. *Decomposition* seems to be produced by external or chemical causes acting upon enamel of good structure. It usually makes its appearance during an attack of sickness, and ceases as soon as the individual returns to a state of health. Its seat is on the side of the molares near the gum, where the enamel will be found soft, white and partially dissolved by some highly acid secretion. If it goes on long, it produces an exposure of the ivory over a large surface and rapid decay.

188. Treatment.—In erosion it is not always necessary to interpose treatment; but if there is any danger of decay, the eroded part should be enlarged and filled with a plug in the manner hereafter to be described. If the dentist is called to a case of decomposition before it has advanced far, he should make the surface as smooth as possible with the file, and direct the constant washing of the mouth with a weak solution of bicarbonate of soda, flavoured with some aromatic. This will neutralize the acid secretion, and diminish at least the rapidity of the disease.

CHAPTER SECOND.

DISEASES OF THE IVORY.

OF DECAY OR CARIES.

189. It will be evident, from the demonstration of the structure and vitality of the tooth, (see *Anatomy*,) that the term caries cannot be received in the same acceptation in which it is held as applied to bones, where it consists of a succession of pathological changes, in which the blood-vessels of the bone play the most important part; a succession best explained by the terms inflammation and ulceration. As the ivory and enamel are not vascular, a similar or even analogous pathological condition cannot exist. We must, therefore, look elsewhere for the explanation of the phenomena of decay. Writers on the diseases of the teeth speak of several different species of decay, and Maury, a Parisian writer, makes six, viz. calcareous, peeling, perforating, black, diruptive, and stationary, all of which arise from a similar cause, acting either in a different manner, or on a difference in the structure of the tooth; for there can be no question but that the perfection of the tooth depends upon the state of the health of the individual during the saccular or formative stage, and that a tooth formed during a period of ill-health, or in a system saturated with mercury, will not be so perfect in its minute organization, as one which is completed in a state of perfect health.

190. *Decay* commences most usually in the fissures of the enamel on the crown of a molar or bicuspid tooth, in which classes it is most frequent, particularly in the last molars or *dentes sapientiæ*; or, where two contiguous teeth come together so as to form a lodgement for foreign substances. In the incisors and cuspidati its most usual seat is on the side of the neck. It also occasionally commences in the ivory under the enamel; and the first evidence of its presence is an opaque spot which, when touched with an instrument, crumbles away and exposes an unsuspected cavity, often of considerable magnitude. Its seat varies with the classes of teeth, depending upon the imperfection or thinness of the enamel; which occurs most frequently on the crown in the molars and bicuspid, and on the side in the cuspid and incisors, the summit or cutting edge in these latter classes being

exceedingly well covered and protected. Its progress is usually in the direction of the tubuli of the ivory and towards the pulp, (for several views of this see Plate IX.) which it soon exposes, creating inflammation of its membrane, and the usual train of suffering which so often requires the prompt removal of the offending organ. If this removal is not practised, it goes on until the crown is entirely destroyed and the fang alone left, when it either ceases or proceeds very slowly and without pain for a long time. In some instances the decay of the whole crown occurs with scarcely any pain, and now and then without any. The colour of the decayed cavity varies with the rapidity of its progress, being black when it proceeds but slowly, and the reverse when its progress is the most rapid. This is at least the general rule on the subject, being liable, however, to vary occasionally.

191. Causes.—Where the commencement of decay is external, it is due to a lodgement of some acid or *acidifying* article of food, (as bread, sugar, cakes, &c., which rapidly undergo the acetous fermentation, when favoured by the warmth and moisture of the mouth,) in the cavities or deficiencies of the enamel, or in the interstices between the teeth near their necks, where the protecting coat of enamel is thin. For a view of the spots most favourable for the commencement of this process, see Plates X. and XII., figures 1, 2, 3, 4, on each. The acid generated having reached the surface of the ivory by this minute fissure or hole, commences to act upon its calcareous portion, after neutralizing the alkaline serum which pervades its tubuli. It first dissolves the calcareous contents of the tubuli, and then the earthy portion of the ivory in their interspaces; this is readily corroborated by immersing a section of a tooth in dilute acid, under the microscope, when the contents of the tubuli will be seen to dissolve first with effervescence. Afterwards, the walls will become slowly transparent, indicating the loss of their calcareous ingredient. The animal portion of the ivory, thus deprived of its calcareous matter, becomes soft, and usually either brown or black, and is gradually mixed with and carried off by the saliva. There is no doubt, at present, that the process is hastened after once an open cavity is formed, by the presence of either animal or vegetable parasites in the decayed cavity, which is an exceedingly proper nidus for such forms, and it is even supposed by Henle,* that this may account for the spread of the decay from one tooth to another. This process is sometimes exceedingly insidious, in consequence of the original opening in the enamel maintaining its primitive size, until great destruction of the ivory has taken place beneath it, when it suddenly breaks in and a cavity is found, where a few hours before none was suspected. In the case where the decay commences on the surface of the ivory under the enamel, the explanation of the process is slightly different. In this case there is no perceptible fissure or hole in the enamel, but a want of union between its basalt, like columns, a porous condition indicated by a slight and scarcely perceptible opacity. The ivory at the bottom of this porous spot is bathed in an alkaline serum furnished by its pulp, (see page 44,) whilst the outside of the tooth is constantly exposed either to the contact of acid or acidifying substances. These are the conditions most favourable to the occurrence of *endosmosis* or transudation, the alkaline matter exuding, and the acid intruding simultaneously. The

* Encyclopedie Anatomique, par A. J. L. Jourdan, Tome, viii. page 453.

ends of the tubuli thus bathed in acid, take it up by capillary attraction and carry it in the direction of the pulp, dissolving the calcareous contents of the tubuli, and presenting the appearance, when examined at this stage, represented in Plate IX. figure 20. The progress, after it has thus commenced, is the same as that just described. The course of the tubuli and their capillary attraction for fluids, causes the decay to progress in the direction of the pulp, hence its investment is soon exposed, and inflammation occurring, toothache is the result. The decay, if suffered to progress, destroys first the crown and pulp, *sometimes* almost without pain, and then becomes nearly stationary, because the sides and not the ends of the tubuli are presented to its exciting cause; the absorption of the acid fluid is therefore very slow, and the rapidity of the decay diminishes in a corresponding ratio.

192. There is a form of decay which is very rapid, attacking generally the neck or sides of the crown of the teeth, over a large space at once, and which from its chalky appearance is called in this country the *white decay*. It is found in a number of members of the same family, and is hereditary, being probably due to an imperfect organization of the enamel in its forming stage. The rapidity of its course, and the extent of surface involved, makes the treatment very difficult, and generally leads to the early loss of the tooth. It differs only in its phenomena being due to a similar cause, acting on a feebly resisting medium. (See Erosion of the Enamel.)

193. There is another variety included under the head of *white decay*, which consists in a denudation or erosion of the ivory just at the neck of the tooth, the gum having previously retreated and exposed this surface to the action of the fluids of the mouth. It differs in a remarkable manner from white decay, as its progress is extremely gradual and slow.

194. It is a curious fact, that when healthy but dead human teeth are used to supply the deficiency occasioned by the loss of one or more teeth, they are liable to decay, and the process follows precisely the same routine, and presents the same appearance as when it occurs in the healthy and living tooth; thus furnishing an incontrovertible argument in favour of the theory given above, and against the now exploded doctrines of Fox, Bell, and others, who attribute decay to an inflammatory action, an action which is impossible in such a structure as the enamel or ivory of a tooth.

195. When the softened and decaying bone is cut or pressed, it usually causes pain; this has been attributed, by writers on the teeth, generally to a sensibility of the ivory, which is, in their opinion, acquired by inflammation, a process which it is plain from the organization of the teeth cannot occur; hence their mode of explanation and their term *inflamed bone* are equally untenable. The true explanation of the pain caused in this way, is as follows.—The tubuli are softened and converted into a state resembling cartilage; the calcareous matter in their calibres is dissolved and replaced by a morbid fluid, which, when the tubuli are compressed by the touch of an instrument, is injected forcibly on to the surface of the pulp, and produces the pain spoken of. When the decayed and softened part is entirely cut away, this pain ceases, because the parietes of the healthy tubuli are too rigid to allow this compression to take place; this is commonly attributed to the removal of the *sensitive* and *inflamed* bone.

CHAPTER THIRD.

TREATMENT OF DISEASES OF THE IVORY.

196. There is no means, in which confidence is placed, for arresting the progress of decay, except the entire removal of the decayed part, and its replacement by some substance which will do no injury itself, and will at the same time prevent the access of all foreign bodies to the ivory. If we reflect, however, upon the microscopic structure of a tooth and the cause of its decay, it must be evident that some substance, which would neutralize the acid producing the mischief, and do no harm itself, must (during its application at least) arrest the process. An alkali would do this, but if used in sufficient strength to neutralize it, would act upon the animal matter, and thus produce the very disease it was intended to cure. It is very probable that the alkaline earths, and particularly magnesia, would succeed perfectly. The cavity might be partly filled with a precipitated magnesia, (not the carbonate,) such as Henry's calcined, and then covered with a cement of mastic and wax. This is only thrown out as a suggestion which may be recommended to travellers or voyagers, in the absence of aid serving to arrest the progress of decay, until they can obtain the services of a dentist and have an operation performed.

197. The radical cure consists in the proper performance of the operation of plugging the teeth. For this purpose, the first thing which the dentist must provide himself with is a convenient chair: of these there are many forms, which it is impossible to notice in a work like this; but we shall describe one which will accommodate itself to every want of the operator, and leave our readers to modify it to suit their particular notions.

SECTION FIRST.

OF THE OPERATING CHAIR.

198. This important piece of furniture has, perhaps, undergone as many modifications as any part of the apparatus used either in this or any other business. From a vast mul-

titude of forms, I have selected the chair invented by Mr. E. B. Gardette, of this city, whose rank as a dentist is above criticism. This chair possesses all the advantages to be desired, and is at the same time so compact, that it enables the operator to be as near his patient as possible, an advantage which few possess. For the purpose of gaining this compactness the arms are placed nearer together than usual, which would prevent a very fat individual from occupying the seat. To obviate this difficulty, there can be removed either one or both in a few minutes by turning a screw. (See Plate XXI.) The legs of the chair are firm and stout, and the seat is made to rise and fall, by means of two racks with corresponding catches, which are placed under it. When elevated to the utmost, pressure upon the knob behind (Plate XXI.) will cause it to fall as low as possible, when it may be again lifted to the desired height. The back is capable of being inclined backwards, and is held at any angle by a perforated arc. It is surmounted by the rest for the head, which is made to fit the head accurately, and is as *small* as possible; it is also capable of a motion backward and forward. Mr. Gardette's chair is handsomely made, but the whole may be constructed at a moderate expense by using inferior wood and materials for stuffing, &c. There is another mode of making the seat to rise and fall, namely, by inserting a piano stool into the middle of the seat, by turning the screw of which it may be made to rise and fall. The chair should be accompanied by a large stool, upon which the dentist may mount behind his patient for the purpose of extracting lower teeth, the mode of doing which is described in the chapter on extraction. It should also have one or two stools of different heights, for patients of different ages, or else have a movable contrivance for the feet to rest upon. Gardette's chair, with the accompanying machinery, is figured in Plate XXI., and the dimensions given to enable any one at a distance to construct a similar one.

199. Another very necessary article is the spittoon, which admits of a variety of forms; a very good one is figured in Plate XXI. figure 6.

SECTION SECOND.

OF FILING THE TEETH.

200. The instruments for performing this operation are called dentist's files, and are imported in sets of a dozen or more. They vary in thickness from one-eighth to half a line, are about three inches long, and about three-eighths of an inch wide. (See Plate XXX. where several forms are given, as at figure 1.) Some of them are cut on both sides and both edges, some on one side and the edges, and others have the sides plain and the edges alone cut, so as to act like a saw. None of them, however, are cut their whole length,

but about one-third is left plain for a handle. They are used to separate the teeth when they are too close, and to remove decay. For this purpose, when the decayed spot is shallow, it may be filed out by including a small portion of surrounding healthy structure, but great care should be taken to file in such a manner, that no lodgement should be effected by foreign matter in future, but that the filed spot be arranged so as to keep *itself* perfectly clean. For the furtherance of this view, a new file should be first used, and the operation terminated with an old or half-worn one, so as to make the newly exposed surface as smooth as possible. Great caution must be used in approaching the dental cavity, and indeed the file should not be used unless the decay is very shallow and easily removed. Filing can scarcely be relied on for the preservation of a tooth, but may be used in the temporary teeth, or where the cavity is of such a nature that it will not hold a plug. The mode of using the file is to hold it gently between the thumb and forefinger and pass it forwards and backwards in a straight line, and with a regular motion; if it should catch between the teeth, it should be very gently disengaged and the movement recommenced.

201. In Filing the *upper* teeth the file should be so held that the forefinger is on the end of it, which not only guards the mouth, but enables the operator to feel what he is about. In some cases it is advisable not to file out the entire decay, but having removed a good portion, the rest may be cut away by an excavator in the form of a very shallow depression, opening backwards into the mouth, which will answer the purpose exceedingly well.

202. Several instruments with handles have been devised to hold files and give them more power. They are particularly useful in filing the molares, as it is next to impossible to give the files, in the ordinary form, the proper direction.

SECTION THIRD.

OF PLUGGING OR STOPPING THE TEETH.

203. This operation, by many considered simple and easy, is in reality a very important and somewhat difficult one. Some prolixity in describing its various stages, and the instruments for its performance may, therefore, be well excused.

204. The first step is to clean out and prepare the cavity for the reception of the plug. When the decay is situated between the front or side teeth, the aperture is difficult to get at, and the operator must, in many cases, commence by passing a file between the teeth so as to separate them; the file must then be used so as to cut away the back part of the affected tooth alone, and only so far as to enable him to get fairly at the decayed part. This part of the operation requires great judgment, which is only acquired by practice; but the best

rule for the beginner is to file as little as possible. In other cases, where the teeth are well separated, by the interposition of a piece of gum elastic for a few days between the contiguous teeth, they may separate so far as to permit the performance of the operation without filing, and after it is finished, they will in a short time resume their previous position in the mouth. Some operators attempt to plug two teeth at once, by forcing the plug between them, in order to prevent the necessity of filing. This is a very bad plan, for the natural motion of the teeth soon loosens the plug, and it does more harm than good.

205. Having obtained room to work at the cavity, the next step of the operation is to clean out the decayed ivory, and form a cavity of a proper shape to receive the plug. For this purpose the operator must be provided with several instruments, called reamers and excavators.

INSTRUMENTS.

206. The reamer or rose-drill is an instrument having a handle with a delicate shank projecting from it, which is surmounted by a little ball like a pea. The ball is *file-cut* and hardened; so that by rotating it in the hand, it files or cuts away the ivory, and produces a cavity; they are shown in Plate XXII. figures 4, 11 and 12. A variety of this instrument in which a rapid motion is given to the reamer by a very ingenious contrivance, the invention of Dr. Everett, is exhibited on a subsequent plate. These reamers should be of different sizes. They are very useful to enlarge the opening in the enamel, but an objection to their use arises from the heat which they create in their rotation, from the pressure which has to be given to them, which necessarily causes great pain. The excavator, which is a more modern instrument, is formed entirely of steel, the handle, about four or five inches long, is delicate, filed octagonal and roughened to give a firm hold. The handle is gently tapered away at one end, and terminates in a little cutter or knife edge, which is kept sharp. These cutters are bent in various directions, so as to enable the operator to clean every part of the cavity, which he does by cutting the decayed ivory away piecemeal. The operation is more quickly and perfectly performed than by the reamer, and gives infinitely less pain, neither producing pressure nor heat. In cleaning away the decayed ivory, care should be taken to give the cavity the best form which the case will admit of.

SHAPE OF THE CAVITY.

207. The best form is that of a hollow cylinder, with a rounded or concave bottom, and not larger inside than at the orifice; for though it might seem to be better, experience has shown, that it cannot be properly filled, and decay will commence its ravages again. It sometimes happens that the cylindrical form cannot be attained; in this case, an oval

form may be adopted, endeavouring to make the sides as straight as possible. When the cavity is very shallow and saucer-shaped, the operator should carve a little shallow groove just within the enamel, which will give greater stability to the plug. As soon as the operator has made a cavity of the proper shape, and removed every atom of softened and discoloured ivory, he wipes out the cavity with several locks of cotton, and pressing the last one firmly into it to keep it dry, he sets about preparing the material to fill the cavity. This is in most cases done at once, but sometimes the cavity is tender and unfit to receive the plug, and at others in making the necessary excavations, the operator has reached and exposed the dental pulp. In the *former* case it is better to defer the filling of the cavity for a few days, and to place in the cavity a small piece of cotton moistened with a *solution of arsenious acid* in water, a piece of wax being placed over the cotton to retain it, and the patient directed not to masticate upon that side until the operation is completed. This solution of arsenic is made by boiling, in a glass vessel, a quantity of pure water, with a small quantity of arsenious acid; when cool it will retain one-fortieth of its weight in solution. This solution is therefore not very strong, but amply so to fulfil the indication, namely, to destroy the sensibility of the freshly cut and exposed ivory. An explanation of this tenderness has been given elsewhere, and from it may be deduced the *modus operandi* of the solution of arsenic. In the *latter* case, where the pulp is exposed, the arsenic should also be applied, but in a different manner. A small portion of the powdered acid should be taken on a proper instrument, and placed at the bottom of the cavity, as nearly as possible in contact with the pulp. Over this should be placed a small ball of cotton imbued with creosote, and over that again a portion of wax and mastic which have been melted together, so as to form a tough and manageable cement. Some dentists are in the habit of adding sulphate of morphia, which when thus applied to the dental pulp more frequently *produces* than *relieves* pain. If morphia in any shape is used, it should be the acetate, for when a salt of morphia is applied to a denuded surface, it has been found that it is decomposed, the morphia being absorbed and the acid left upon the surface. Hence, when the sulphate is used, the acid thus left often produces great pain and ulceration, which does not obtain with the acetate. Things should be allowed to remain three or four days, when the cavity may generally be emptied and the plug applied. The pain which is excited by the escharotic action of the arsenic is not often severe, and usually lasts from one to three hours. Sometimes it is followed by soreness in the alveolus and slight protrusion of the tooth. When this is the case the operator must wait until it subsides. The quantity of arsenic used need never exceed the one-sixteenth of a grain, which would do the patient no injury if swallowed. Arsenic used in this way, has the advantage of first destroying and then preserving the pulp perfectly, so that no change will afterwards occur in it.

MATERIALS FOR FILLING THE CAVITY.

208. The only legitimate and regular materials for this purpose are tin foil and gold foil. Besides these there are one or two resinous substances, such as mastic, and wax,

also fusible metal, and sundry *so called mineral* cements. Gold foil is in all cases to be preferred, on account of its indestructibility and its perfect preservation of the tooth when properly applied. It must be pure, or it will not possess the necessary softness, and should be in rather large leaves. Tin foil is applicable in cases where the expense of gold cannot be incurred, and where gold will not keep its position, for in consequence of its softness, or some other property, it forms a much closer adhesion to the walls of the cavity. Some dentists are in the habit of putting tin foil into the bottom of a large cavity, and covering it over with gold for the purpose of saving the gold, and this is sometimes done with the knowledge of the patient. The practice is highly reprehensible in either case; for the galvanic action which occurs from the contact of two dissimilar metals, inevitably produces the destruction of the most oxydizable; and besides this, it has been more than suspected of *producing* the decay of the tooth, the very thing to *prevent* which, it is used.

209. Wax is sometimes used by those able to apply it themselves to the incisors, because its colour conceals the decay; but wax and mastic and their congeners, must be looked upon as mere temporary expedients, not deserving of confidence. The fusible metal of D'Arcet, made more fusible by the addition of one-tenth part of mercury, is used in France, and is applied by instruments with round heads, heated to 212° F. by a cup of boiling water. It is easily applied to the teeth of the lower jaw by drying the cavity and putting two or three pieces in the cavity, and then using the hot instrument; as it becomes pasty, it may be spread like plaster to fill completely the cavity. The objection to its use consists in the temperature at which it is applied, which in many cases could not be borne, and in all must excite a greater or less degree of inflammation. D'Arcet's metal is made as follows:—

Bismuth, 8 parts,
Lead, 5 parts,
Tin, 3 parts.

The lead is first melted, and then is ready to receive the tin and bismuth. After it has somewhat cooled, one and a half parts of mercury may be added and the metal poured into a paper mould.

210. The mineral cement so much vaunted by quacks, is formed by making a fresh amalgam of silver and mercury, and pressing it into the cavity when soft; the action of the saliva soon hardens it so that it cannot be cut. The silver must be in a finely divided state, and is prepared as follows:—Take any quantity of silver, such as coin, and dissolve it in nitric acid slightly diluted with water; when the solution is complete, dilute with more water and strain or filter it; then add gradually a clear solution of common salt, taking care not to add an excess, which will re-dissolve the dense white curdy precipitate which rapidly falls to the bottom. Now decant the supernatant clear liquid and wash the precipitate with hot water two or three times, each time letting it subside previous to pouring off the clear liquid; then fill up the vessel with water, and acidulate it with a few drops of sulphuric acid, and then immerse in it some clean slips of sheet zinc. Bubbles of gas will rise from the zinc, and in a few hours the white precipitate will have changed into a

gray metallic powder, which is pure silver in a state of extreme division. This must be washed and dried and kept in a well stopped bottle for use.

211. The objections to this so called cement are many. It turns black and rough, and has an unsightly appearance. It keeps mercury in the mouth ready to be oxidized and dissolved by the food and fluids of the mouth, and thus affect the system. It never gets solid, but remaining porous favours an extension of the decay by its endosmotic action. It cannot be removed by any instrument to be replaced by a better plug.

212. There is another and perhaps better plan of preparing the silver by Dr. W. Gregory, as follows:—The chemist, as well as the metallurgist, has frequent occasion to purify silver, especially from copper, which is dissolved along with it by nitric acid, the proper solvent of silver. By converting the silver into the insoluble chloride, it is effectually purified from copper as well as from all other metals, the chlorides of which are soluble. But here the difficulty begins; the chloride of silver is a very unmanageable product, at least in the moist way. It is true, that if placed in water acidulated with hydrochloric acid, in contact with zinc or iron, the chloride of silver is reduced. But the process is tedious, seldom complete, and in the end unsatisfactory, for some zinc adheres to the reduced silver, so that it is not removed by digestion with moderately strong hydrochloric acid. This is proved by the action of ammonia, which extracts a good deal of oxide of zinc. Moreover, the zinc or iron is hardly ever pure, and its impurities, arsenic, carbon, and perhaps also copper and tin, remain with the silver. I have never got from silver thus reduced a colourless solution of nitrate.

213. After describing the objections which attach to the different methods which have hitherto been adopted for obtaining the silver in a state of purity, the author says,

214. The following method appears to me the most advantageous:—

215. The cupreous solution of silver is precipitated by common salt, while hot, and the chloride of silver well washed by decantation with hot water. It should also be broken down with a spatula of platinum, or a glass rod, during the washing; but not ground in a mortar, which causes it to cake, and impedes the action of the potash. The chloride, *while still moist*, is covered to about half an inch with a solution of caustic potash, specific gravity 1·25 at least, and then boiled. During the boiling, which is best performed in a capsule of clean iron, silver, or platinum, the chloride is to be well stirred, in order to bruise all curdy or lumpy particles. If a small portion, taken out and washed, do not dissolve without residue in dilute nitric acid, the potash is to be decanted off, and the powder, still moist, is to be well rubbed down in a mortar, which may *now* be done with advantage. It is then returned into the capsule, and again boiled for five minutes, with the same or with fresh potash. It will now dissolve entirely in nitric acid, but if not, a second grinding will infallibly succeed. It is now only necessary to wash the oxide, which is completed by decantation in a few minutes, as the powder, from its great density, sinks at once to the bottom. The first two or three washings are made with hot water, the remainder with cold water, for when the oxide is nearly washed, it rises partially to the surface with *hot water*, and thus a loss is occasioned in decanting. Of course, the whole

washings (except the first, owing to the strength of the potash) may be conducted on a filter. But the powder is so fine, that probably a good deal would adhere to the paper when dry.

216. This oxide of silver appears in a form quite distinct from that of the oxide precipitated by potash from the nitrates, and is hitherto undescribed. It is very dense, homogeneous, and has a pure black colour, which has, if any thing, a tint of blue, whereas the common oxide is bulky, far less dense, and of a grayish-brown colour. They appear, however, to be chemically identical. Not having a microscope, I have not studied their physical characters minutely, but I suspect, from its aspect in the liquid in which it is formed, that the new oxide is crystalline.

217. It is obvious, that the above process furnishes an easy method of procuring a very pure oxide of silver, and of course the action of heat gives us the silver in the state of metal. It is, I conceive, applicable both to the manufacture of nitrate (in a state of absolute purity) and to the metallurgic process for obtaining pure silver. For both objects, it is a matter of no consequence if some chloride should have escaped the action of the alkali. This chloride is left undissolved by the nitric acid, and is separated by filtration, while if the oxide (not quite free from chloride) be mixed with a little nitre or carbonate of potash, and fused, the whole silver is obtained with the utmost facility. In order to give an idea of the ease with which the whole is performed, I may mention, that I dissolved a half-crown, and obtained the whole of the silver it contained, within a very trifling fraction (chiefly decanted in the *first* washing of the chloride, *but not lost*) by the above process, *within two hours*, in a fused state. The silver was quite pure. There is no doubt that to chemists, also, an easy method of obtaining quickly, pure oxide of silver, in a form much less hygrometric than the usual one, will be acceptable.

218. It is particularly to be noticed, that if the chloride *have once been dried*, it is with great difficulty decomposed, even by a long boiling with potash. Having obtained the pure oxide by Dr. Gregory's process, it is to be placed in a vessel of hydrogen gas and heated to 212° F., when it will be reduced in the form of a powder of chemically pure silver.

219. If the material chosen by the operator be one of the metallic foils, it must be cut into a long ribbon by the scissors, and then rolled up into a little rope, or it may be folded and cut into the form represented in Plate XXV. figure 8, it is then ready to be pressed into the prepared cavity by the plugging instrument. The cavity being clean and *dry*, one end of this little rope is placed at the bottom of it, and by a small instrument it is folded over and over, and round and round, until the cavity is full. The pressure during the filling must be gentle and regular; it must bring the several layers in contact, but must never be so great as to cut through one layer or to separate the little cord of foil. When the cavity is full, it is formed into a little conical heap, and the small instrument is laid aside and a somewhat larger one taken, by which as firm pressure is made as the tooth will bear, to condense the metal well into the cavity. It is occasionally useful to increase this pressure at the edges of the cavity by a very small plugging instrument, which makes the metal very solid and causes it to hold well. After this the excess of metal is filed off, and

its surface made perfectly smooth and polished by the burnisher, of which there should be several varieties. (See Plate XXII. figures 6, 7 and 8.)

220. When the plug occupies the centre of the crown of one of the molars it must not be filed, but must be pushed or cut into a concave form and then highly burnished. Many other directions might be given, but the operator's ingenuity will enable him to apply the above to almost any case he may be presented with.

221. The instruments for pressing in the metal should be of various sizes and curvatures, so as to adapt them to all situations and sizes of cavity. Several of the more common forms are given in Plate XXII. figures 1, 2 and 3.

222. When a plug comes out, which is very rare if the foregoing precautions be taken, it will probably be owing to the shape of the cavity, which must be altered by the excavator before re-applying it.

CHAPTER FOURTH.

DISEASES OF THE CEMENTUM.

223. These consist in *hypertrophy* and *atrophy*. *Hypertrophy* is produced by some disease in the periosteal covering of the fang, analogous to that of the periosteum of the bones which produces *exostosis;* this causes the periosteum to secrete an immoderate amount of cementum in successive layers, so as to give an exceedingly deformed appearance to the fangs, occasionally forming a ball at the point, which presents a serious obstacle to the extraction of the tooth, and in some rare instances forming a bony union with the alveolus, thus fusing the tooth into the jaw. When the affected tooth is struck gently it usually gives pain. *Atrophy* is also the result of periosteal disease, which is of a higher grade, and instead of depositing, erodes by the absorptive process the cementum from the surface of the fang, and may go on to attack and destroy the ivory. It is always attended with inflammation and suppuration of the alveoli and gums, which produces indigestion by the quantity of purulent and fetid matter constantly swallowed by the patient. Both these diseases are, therefore, a mere effect produced in the cementum by an abnormal condition of the periosteum, and not properly treated of under this head, but as it is the place to which a reference would most naturally be made, it was thought better so to classify them.

224. *Treatment.*—Hypertrophy is rarely suspected until the tooth comes to be extracted, when it is too late to interpose a remedy. *Atrophy* requires both local and constitutional remedies. The former should consist of vegetable astringent washes, of which the best is a solution of pure tannin, made of a strength to suit the case, and the latter of the administration of large doses of iodide of potassium, say to an adult ten grains three times a day. I have known several cases entirely cured in their early stage, by the removal of two or three of the teeth most affected, and the above treatment continued for six or eight weeks.

CHAPTER FIFTH.

DISEASES OF THE DENTAL PULP.

225. These are all included under the term *odontitis*, or inflammation of the pulp, which terminates either in *resolution*, *suppuration*, or *gangrene*.

226. *Causes.*—Inflammation of the pulp is almost always produced by the exposure of its investing membrane in the progress of decay. When its cavity is perfect, it is but little liable to this process, although cases have occurred where from blows or the sudden alternations of heat and cold, it has taken place in a sound tooth.

227. *Symptoms.*—When it occurs from exposure it gives rise to the most excruciating pain, which occurs usually in paroxysms of longer or shorter duration. The pulp swells and protrudes slightly through the little opening in the wall of the dental cavity. The usual duration of this painful affection is three days, when it terminates in suppuration or gangrene. When from the subsidence of the inflammation, or by the use of appropriate remedies resolution occurs, the pain either ceases or is converted into a very bearable soreness, but is instantly renewed by any change of pressure in the mouth, as by the patient's sucking or attempting to blow any instrument, such as the blow-pipe. The first of these manœuvres causes the pulp to protrude, and the second to retire, and even if carried far to force a minute bubble of air into the cavity. The consequence of this is, that a new attack of inflammation is produced with all its concomitant suffering. When the inflammation terminates in suppuration, and the pus finds vent from the cavity, enough of the pulp is destroyed after a time to afford plenty of room in the cavity for the remainder, and the patient is but little troubled, unless in eating, some portion of soft food is injected into the cavity and pressing upon the nerve renews the inflammation; but if the aperture serving to discharge the matter becomes closed by any accident, a kind of pain is immediately produced, which occurs in short and very severe paroxysms, and is usually called the *jumping toothache.* Its severity is such, that few persons will submit to endure it, until the pus accumulates in such a quantity as to force a passage, but fly to extraction for relief. When after two or three days severe suffering, the pain suddenly terminates, *gangrene* has taken place and the sufferer is relieved, but the tooth inevitably becomes of a deep blue colour, and is thenceforward a dead tooth or foreign body.

228. *Treatment.*—When a tooth commences to ache, and the pulp is found to be exposed,

the cavity should be gently wiped out, and then filled without much pressure with a little ball of cotton, which has been imbued with pure creosote. I say pure creosote, for if from exposure to the light and air it has become brown and lost its fluidity, it is no longer fit to relieve toothache. Its mode of action is not perfectly understood, but the relief obtained from its proper application is in most cases prompt and perfect. The effect only remains whilst the creosote is present, so that it must be renewed at least once in twenty-four hours. I am aware that many dentists very honestly disbelieve in the power of creosote to relieve this disease, but I fear they have either applied an inferior article, or used it in an improper manner, or have trusted to it in dental *periostitis*, a totally different affection, often mistaken for true toothache, and to be described hereafter.

229. Many other articles have been at various times recommended and with various success, but are inferior to creosote in power. They are oil of cloves, nut gall, camphor, camphorated spirit, a mixture of nitre and alum, oil of sassafras, and pure potash dissolved in alcohol, tincture of pellitory, &c. Of these the last, the tincture of *pyrethrum album*, or the pellitory of Spain, deserves some attention from the mode of its action. It is put by means of a piece of cotton between the affected tooth and the cheek. Spreading over the surface of the cheek, it excites a sensation like that which would be produced by a million of little ants crawling over the side of the cheek, and causes a profuse flow of saliva from the parotid gland. The relief, when afforded, is derived from this counter-irritation, and the depletion from the neighbourhood of the inflamed part by the excessive secretion of saliva. The benefit derived from these various articles may be increased by the use of hot and stimulating baths to the feet, and by gently drawing air past the affected tooth so as to cool it slightly. If these remedies fail extraction must be resorted to, or the pulp must be destroyed.

230. Various methods have been adopted at different times to produce this result, such as drilling it out, the application of the actual cautery, nitrate of silver, and mineral acids, all of which are objectionable in consequence of the inflammation which they produce. The best plan is to clean out the cavity slightly, and apply to the pulp as closely as possible a very small quantity of pure *arsenious acid.* I say pure, because the common arsenic of the shops will not answer, and again, because many dentists are in the habit of mixing it with sulphate of morphia to diminish the pain, than which there cannot be a greater mistake, for the latter article both increases the pain and impedes the escharotic action of the arsenious acid. The arsenic thus applied not only destroys the vitality of the pulp, but it combines with the animal matter of the pulp, and forms a compound incapable of putrefaction. It causes some pain for three or four hours, when it ceases, and in a day or two the tooth may be plugged. No fears need be entertained of swallowing this minute quantity of arsenic, about one-sixteenth of a grain, as the usual dose of this medicine is from the one-sixteenth to the one-twelfth three times a day. The pulp may be partially destroyed or shrunk so as to permit the plugging of the tooth, and almost without pain, by the daily application on a piece of cotton, of a saturated solution of tannin or gallic acid in alcohol, to which a small quantity of creosote has been added.

231. When the disease has progressed to the suppurative stage, and it is desirable from any cause to save the tooth, it is best done by the application of a minute portion of pure *arsenious acid* to the dental cavity, which is then covered by wax or a mixture of wax and mastic, and renewed once a week for three or four times. By pursuing this plan the offensive discharge will cease, and the tooth may be plugged and worn for an indefinite length of time. The same application is recommended where gangrene has taken place, to overcome the fetor and allow a plug to be applied; for if a tooth with a gangrenous pulp be plugged without it, it will surely give pain, and when extracted and broken or the plug taken out it exhales the very quintessence of fetor.

FALSE ODONTALGIA.

232. There is a form of toothache which is produced by irritation of the maxillary nerve at a distant point, and may with great propriety be called false toothache. It may, and commonly does, exist in a perfectly sound tooth, and frequent mistakes are made by the dentist, who on the representation of the patient, extracts a perfect tooth, and leaves a diseased one, the cause of the mischief, behind. Care should be taken therefore when a patient comes to have a sound tooth extracted, to examine the mouth well, and remove the diseased member, which is the cause of the mischief, when the false toothache will immediately cease. From some peculiar arrangement of the nervous supply, this affection is very apt to attack either the opposite tooth in the same jaw, or in the opposite one. Thus from the decay of the first molar in the lower jaw, right side, the pain will be felt in the first molar in the left side of the same jaw, or in the right first molar of the upper jaw.

233. *Treatment.*—This is to be treated on the same principles as true toothache, taking care to apply the remedial measures to the decayed tooth which is the true seat of the malady.

SECTION FIRST.

INFLAMMATION OF THE DENTAL PULP IN AN UNDECAYED TOOTH.

234. But little attention seems to have been paid by writers to the possibility of this occurrence, which, although rare, is still frequent enough to demand a notice.

235. The disease consists essentially of an inflammation, generally acute, of the pulp, which rapidly passes through its stages and terminates in gangrene, owing to the confined condition of the part.

236. *Causes.*—It may arise from cold, the use of mercury, heat applied to the tooth, or from the effects of a blow.

237. *Symptoms.*—It commences by an aching and soreness in the affected tooth, which when examined is found to be perfectly sound. The pain is aggravated by taking hot liquids into the mouth, and soon extends to the neighbouring teeth, not unfrequently producing a severe attack of neuralgic pain in the side of the face and head. In case of several teeth sympathizing, the affected one may easily be detected by striking them gently with a key or some hard instrument. The pain is violent at first but generally soon subsides, and frequently in quite a sudden manner, nothing being left but a soreness and slight protrusion of the tooth. In this case gangrene has taken place, which is made manifest by the exhalation from the dental cavity when the tooth is extracted and broken.

238. *Treatment.*—The treatment of this affection is based upon the same principles as the treatment of any other acute local inflammation. The system does not sympathize, and consequently general or constitutional treatment is seldom called for. Advantage, however, will in all cases be derived from the administration of an active saline purgative.

239. The local treatment must consist of the application of leeches as near as possible to the point of the fang, the avoiding of hot and cold substances in the mouth, and the application of an opium plaster on the cheek. If these means fail to produce a resolution of the inflammation and gangrene results, extraction is the only remedy.

SECTION SECOND.

OF FUNGUS OF THE DENTAL PULP.

240. When decay has advanced so far as to expose the dental pulp, and fear or some other cause prevents the patient from having the tooth extracted, the pulp is very apt to throw out a vascular fungus which occupies the decayed cavity. This fungus varies much in its characters; being hard or soft, and either exquisitely sensitive, or utterly devoid of sensibility. When cut or touched it generally sheds blood freely, having yielded in one case as much as eight ounces.

241. *Treatment.*—The proper treatment for this disease is extraction, but as this is to be avoided in hæmorraghic diathesis, the application of arsenic or nitrate of silver to the fungus, as directed for the destruction of the pulp, will doubtless succeed perfectly.

CHAPTER SIXTH.

OF PERIODONTITIS OR ALVEOLAR PERIOSTITIS.

242. This affection consists of an inflammation of the fibrous structures which exist between the fang and its appropriate alveolus. It is divided into two forms, *acute* and *chronic.*

243. *Causes and Symptoms.*—The acute form generally arises from the extension of inflammation from the pulp through the minute foramen at the end of the fang. When this is the case it may be general or partial. When *general* it is evidenced by a painful condition of the tooth, different from toothache proper, the pain being duller but more constant, and the tooth protrudes from the socket and is sensible to the slightest touch.

244. When it is local, it is caused by the discharge from a suppurating pulp, being suddenly prevented from escaping by a closure of the cavity in the crown; the matter is then forced through the foramen into the bottom of the alveolus and excites acute inflammation which soon terminates in suppuration. The matter when formed is shut up as it were in a small space, and creates great pressure and a corresponding amount of pain, which is throbbing or pulsating. The usual route for the escape of matter being stopped, it has to seek a new one, and either escapes between the fang and alveolus, or causes the absorption of the bone, which is commonly thin over the point of the fang, (see Plate II.,) and distending, the tissues on the outside form a circumscribed and very painful tumour, which is called a gum-boil; when this breaks or is opened, the confined matter escapes and the pain and inflammation subside.

245. The orifice does not heal usually, but continues to afford a vent for the pus, and becomes converted into a callous sinus, which will remain until the tooth is extracted. If things are allowed to remain a long time in this condition, it will be found that a species of fungus like a little cabbage, has formed upon the end of the fang, and the jaw will be hollowed out into quite a cavity around it. Occasionally the abscess is not so circumscribed, but the cheek swells and may become the seat of an abscess, which if allowed to open externally, makes a very ugly scar. When the wisdom teeth are attacked, the abscess is often very extensive, extending into the palate, and in one or two cases which I have seen

it separating the side of the pharynx from the adjacent structures and seriously impeding deglutition.

246. The chronic form is usually produced by the abuse of mercury, and may sometimes have a venereal origin. In this form the inflammation is of such a grade, that soreness, attended with looseness of the teeth, is the only pain which the patient complains of. On examining the edges of the gum, they will be found to be ulcerated and constantly discharging a greenish and fetid pus. This produces an absorption of the fang, which is treated of in the chapter on atrophy of the cementum. When this form of disease is produced by mercury, it extends to the shell of bone which lines the alveolus, which becoming necrosed exfoliates, and the teeth drop out surrounded by, and adherent to, their sockets.

247. *Treatment.*—When acute periostitis has set in, the best remedy is to apply two or three leeches to the gum, close to the edge of the affected tooth, and to follow it by the application of some emollient substance, such as the bark of the slippery elm chewed and held between the cheek and the jaw. The tooth should also be cooled frequently by drawing air into the mouth in such a way as to make it blow over the affected tooth. When *gum-boil* forms it should not be allowed to break, but a strong and sharp lancet should be pushed perpendicularly down to the fang, which will give instant relief. If the cheek suppurates, the opening must be made early and on the inside, to prevent disfigurement. If the abscess from a wisdom tooth threatens the throat, the tooth should be promptly extracted, for even fatal consequences may ensue from its extension.

CHAPTER SEVENTH.

LOOSENING OF THE TEETH.

248. This either takes place in individuals who have taken immoderate quantities of mercury, or in aged individuals after the loss of several teeth. In both cases its progress is gradual, although the pathological condition is entirely different. In the cases where it arises from the abuse of mercury, there is usually no appearance of disease either in the pulp or periosteum of the alveolar cavity, but the lining bony plate of the alveolus exfoliates, carrying the tooth with it, so that when taken in the hand we have the tooth with its pulp, periostea, and a thin shell of bone surrounding the whole fang. The pathological changes which lead to this result, are first inflammation of the pulp and periosteum which extends to the alveolus itself; secondly, *sphacelus*, or the death of the part, which rapidly follows and terminates the inflammatory action; the tooth and its investments having then become a foreign body are detached by the action of the absorbents, which are stimulated by the mercurial impression and do their work very promptly. Sometimes the inflammation spends itself on the periosteum and suppuration occurs as a termination, instead of sphacelus; in this case it takes the form of alveolar periostitis, (for an account of which see chapter sixth,) loosening and exfoliating the tooth without any portion of the socket. In this latter case the process is much more painful and tedious than when the socket is exfoliated with the tooth.

249. The remedy for this form of loosening is only applicable to the first or inflammatory stage, but in consequence of the rapidity of the mercurial action, can rarely if ever be successful. It must consist of some medicament which will destroy the mercurial impression as rapidly as possible, such as large doses of hydriodate of potash taken internally, and a pretty strong solution of the same used as a mouth wash.

250. When loosening of the teeth occurs in old persons, it arises from the gradual filling up of the dental cavity by *cementum*, and the pressure upon the foramen in the tip of the fang by the gradual accumulation of the same substance at this point. These causes finally produce the obliteration of the artery supplying the pulp, and the tooth being henceforth a dead or foreign body is slowly cast off or exfoliated. These cases need not be meddled with unless soreness or inflammation take place, or the individual wishes a false set, when they must be extracted.

CHAPTER EIGHTH.

LUXATION OF THE TEETH.

251. Luxation of a tooth, is its forcible removal from the socket to a greater or less extent, but in all cases short of extraction. There is consequently some few of the attachments of the tooth to the alveolus left in such cases. Luxation is produced by falls, blows, and from the improper application of an instrument for the extraction of another tooth. It is sometimes purposely produced, for the purpose of relieving toothache, without losing the tooth, a manœuvre which seldom succeeds, and is now given up by all scientific dentists. When the luxation is slight and the tooth young, its nerve, artery and vein may not be torn, and in this case its re-adhesion to the socket and subsequent growth will not be interfered with; but if the tooth is fully formed, the vessels and nerves of the pulp will be torn, and the greatest difficulty will be presented in causing it to re-adhere to its socket, as it has now become a foreign body, and the natural tendency of the socket is to throw it off or cause it to exfoliate.

252. *Treatment.*—When the *permanent* tooth of a child is dislocated, it should be replaced with great gentleness, and the child fed for a few days on spoon victuals, being told not to touch the tooth with its tongue. If any difficulty should be found in retaining it in its place, it should be secured with ligatures. Should the accident occur to one of the temporary teeth, this care need not be taken, but it may be at once extracted. There is but little benefit to be derived from replacing the dislocated tooth of the adult, particularly if its connections are much torn up—for protrusion of the tooth from the socket, constant soreness, and sometimes suppuration around it, will generally cause the patient to fly to extraction for relief. If the connections should not be much torn, the tooth may be replaced, and by leeching the gum, &c. the inflammation and soreness may possibly be overcome. The practice of luxating a tooth purposely with the object of saving it, has been tried so often and with such constant want of success, that it cannot be spoken of except in terms of condemnation, and is at the present time wholly abandoned.

CHAPTER NINTH.

OF TARTAR AND ITS EFFECTS.

253. Tartar is a substance which forms around the necks of the teeth and on the sides of the crowns, particularly in situations opposite to the orifices of the salivary ducts. These ducts are the *parotid*, situated in front of the ear, and having the opening of its duct opposite the middle molar of the upper jaw. The *sub-maxillary*, situated under the lower jaw on each side, and opening by its duct on each side of the frænum under the tongue. The *sub-lingual*, under the tongue, opening by six or seven orifices on the side of the frænum, and numbers of small glands inside of the lips and cheeks, called *labial* and *buccal* glands. The greatest amount of saliva is furnished by the *parotid*, flowing over the outsides of the *molares*, and by the *sub-maxillary*, poured out behind the lower incisors. In these two situations the most rapid accumulation of tartar takes place.

254. Tartar was at one time supposed to be secreted by certain glands described by Mr. Serres as tartar glands, a view of which is given in Plate VIII. figure 4, but this opinion is untenable at the present day. The glands described by Mr. Serres, are probably mucous glands in a state of irritation, perhaps of suppuration, from the excitement of dentition, as they are only observable at that time.

255. Tartar is a *deposit from the salivary* glands, and is sometimes formed in the ducts of the glands themselves, constituting *salivary calculi* or *concretions*.

256. When first deposited it is in the form of a soft yellowish white substance like chalk and water, and easily removed by a brush. It soon becomes slightly fetid, and examined by the microscope is found to be filled with living animalculæ. It begins to harden after a time, and assumes a consistence superior in hardness to common chalk, but never gets to be as hard as the enamel. When scratched or cut it is found to be gritty, and it either retains its yellowish white colour, or is stained green or black by the aliment, a change in colour most apt to occur on the front teeth, giving them a very dirty and unpleasant appearance.

257. The tartar consists then of the solid portions of the saliva, mixed with mucus and the debris of microscopic animals. Its analysis, as given by Berzelius, is as follows:—

ANALYSIS OF TARTAR.—*Berz.*

Phosphate of Lime and Magnesia, - -	79·0
Salivary Mucus and Salivine, - - -	13·5
Animal Matter, - - - - -	7·5
	100·0

258. The analysis of salivary calculi from the human subject has not been made with care, but annexed is the analysis of the salivary calculi from the horse, ass, cow, and elephant, by M. Lassaigne.

Carbonate of Lime, -	84·
Phosphate of Lime, -	4·
Animal Matter, - -	9·
Water, - - -	3·
	100·

SECTION FIRST.

BAD EFFECTS OF THE ACCUMULATION OF TARTAR.

259. In a healthy and clean condition of the teeth, the gum embraces the neck of the tooth closely, and forms a sharp fold where it turns over just at the margin of the enamel. The inside of this fold is filled with mucous crypts, which secrete a thick transparent mucus, which is constantly exuding between the gum and the tooth, and mixing with the fluids of the mouth. In this way foreign substances are prevented from remaining between the gum and the neck of the tooth, being washed out by the exudation. When the incrustation of tartar once takes place, its effect is to cause absorption or ulceration of this beautiful provision for the preservation of the teeth, and by denuding the neck to gain room for an increased deposit. As the deposit increases, the alveoli themselves sometimes recede before it, and the tartar may go so far as to enclose the greater part of one or more teeth in a common mass. Examples of this from Fox and other authors are given in Plate IX. figures 30 and 31, and Plate XII. figures 8, 9, 10, 11, 12, 13 and 14.

RECESSION OF THE GUMS.

260. The above effects of tartarous accumulation, must not be confounded with the recession of the gums from disease in their tissue, which is shown by several examples in Plate XII. figures 2, 4, 5, 6 and 7.

261. *Treatment.*—When the tartar is very thin it may be removed by the use of a little dilute muriatic acid, which, however, has the bad effect of attacking the enamel, and doing it more or less injury. It should be applied by wetting a minute dossil of cotton on a pointed piece of rattan with the acid, and just wiping the tartar with it, when the mouth must be immediately rinsed with warm water.

262. The only truly rational mode of removing the tartar, however, is by means of a set of instruments called *scalers*, which are made in various forms to adapt them to the nooks and crannies among the teeth, which are the seat of the deposit. All the useful forms of these instruments are figured in Plate XXIII. figures 1 to 11 inclusive. They are used as scrapers, with a rotary motion something like grinding, and are applied with just force enough to remove the incrustation of tartar, and not enough to injure either the enamel or the neck of the tooth. The enamel is so hard that but little caution is required to remove the tartar from its surface, but great care must be exercised at the neck of the tooth, the tartar must be wholly removed or the gums will refuse to re-embrace them, but the layer of cementum which protects the ivory, and is at this part very thin, must not be cut through. When the tartar is thick it may be hooked up and lifted as a cake from the surface of the tooth; this is very readily done behind the inferior incisors. After the scaling or scraping, the teeth should be polished with a little dentifrice on a dossil of cotton. During the operation the lips of the patient must be held out of the way by a finger of the left hand, and he should be directed to rinse out his mouth from time to time. Should much fetor arise from the mouth, the dentist will gain much comfort from adding a drop or two of creosote to the water.

263. Recession of the Gums must be treated by astringent applications and frequent scarifications with the lancet. The best, perhaps, of the astringents, is the tincture of rhatany, though a solution of pure tannin contains the virtue of all the vegetable astringent washes. The patient should also be directed to use a soft brush, as the use of a hard brush, particularly when assisted by some of the gritty dentifrices, will cause the denudation of the fangs, and finally the loss of the teeth.

CHAPTER TENTH.

ON EXTRACTION OF THE TEETH.

264. Although this is the last resort of the scientific dentist, it is in some cases the only one, and in many parts of our country, the practice of the art is confined entirely to the performance of this operation. The importance of removing decayed and painful teeth, without injury to other teeth or the surrounding parts, will excuse some detail, both in describing the instruments and dwelling upon their respective advantages. In giving the account of certain instruments, it is impossible to avoid omitting a few which are highly thought of, by their *inventors*, and perhaps passing over some highly meritorious forms; but in the present work those only will be described, of which the utility has been tested by many trials and long experience, and to avoid discussion, no reference will be made in any case to the name of an inventor.

SECTION FIRST.

OF THE INSTRUMENTS FOR EXTRACTION.

OF THE KEY INSTRUMENT.

265. This instrument, which still holds a sort of pre-eminent rank with many operators, has been almost entirely abandoned by others; a fact which can only be accounted for by the skill which has been obtained by those who continue to use and to praise it; but it is to be feared that this skill was only acquired by repeated failures, and fractures both of the teeth and the alveoli, so that the operator might say, (like a celebrated oculist once did,) that he had sacrificed a hatful of teeth in learning to use the instrument. It cannot be denied that the key is applicable to some cases not easily relieved by any other instrument, and that great dexterity may be acquired in handling it, so that almost any tooth

may be extracted by it; but as a general rule, its use is to be deprecated, and the forceps substituted wherever they can be applied. Directions will be given at the end of this chapter, which will put the student in the way of using this instrument to the greatest advantage; at the same time every argument will be used to prevent him from taking it up, except when nothing else will answer his purpose.

266. The key instrument most probably derived its name from the fact of a common key having been first used for this purpose, a circumstance which is rendered highly probable by the fact (for which I am indebted to my friend Mr. Glyddon) that the famous surgeon of Cairo, Clot-Bey, is in the habit of taking out his friends' molars by means of a common key and a piece of twine, an operation which he is said to perform with great dexterity and rapidity. Although copper forceps for extracting the teeth have been found in the pyramids of Egypt, there is nothing which resembles the key, which goes to prove that the invention of the forceps were antecedent to that of this latter instrument.

DESCRIPTION OF THE KEY.

267. The key consists of four principal parts, which have been variously modified to suit the notions of inventors or improvers, but the simplest form is yet the best, and will be preferred by the skillful operator. With a little dexterity every thing may be done with the instrument in its simple form which can be done by any of the varieties or complications. Dr. Franklin's remark is applicable. "I would not give a cent for a *workman* who could not saw with a gimblet or bore a hole with a saw."

268. The parts alluded to are the *handle*, the *shank*, the *bolster or fulcrum*, and the *claw*.

269. The *handle* is made of ebony, ivory, or mother of pearl, and should be large enough to feel comfortable in the hand. It is placed at right angles to the shank at its upper end, and should be made removable to render the instrument more portable. (See Plate XVII. figure 1.)

270. The *shank* is bent upwards shortly after leaving the handle, with the double object of placing the lower part of the fulcrum (which forms the pivot or centre of motion) on a line with the straight part of the shank, and of avoiding the anterior teeth in applying the instrument. The distal end of the shank is usually perforated, and contains some contrivance for changing the claw, usually a sliding pin urged by a spiral spring. (See Plate XVII. figures 3 and 4.)

271. The *fulcrum* is subject to more changes of form than any other part of the instrument, but the best is represented in Plate XVII. figure 3 and 3, a. Sometimes it is movable, as in figure 1, 1, *a*, and 1, *b*, which enables it to accommodate itself to any irregularity of the tooth, and sometimes it is nearly spherical, as in figure 2. In Europe it is generally made rough, so that it may be wrapped advantageously, but the smooth

fulcrum is the easiest to use and requires no wrapping, which is disadvantageous, as it prevents the operator from choosing his claw properly, for when he has adjusted its size by the eye, the pressure upon the wrapping will condense it, and thus increasing the space between the point of the claw and the fulcrum, will deceive the operator and perhaps break the tooth.

272. The *claw* is a curved piece of steel tempered to a blue colour, and hinged at one end to the pin in the end of the shank. The other end terminates in two sharp points which give it a firm hold on the neck of the tooth. A form of the claw at Plate XVII. figure 5, is highly recommended by F. S. Prideaux, of London, for the power which it gives him to force its point low down on the neck of the tooth by turning the key the reverse way. The claws must be of different sizes and curves, and either the plan for turning and changing them described above must be adopted, or some other such as is shown in Plate XVII. figures 1 and 2.

DISADVANTAGES OF THE KEY.

273. The disadvantageous points in the use of the key, are the injuries which the pressure of the bolster inflicts upon the surrounding parts, and the occasional fracture of the tooth. This latter accident will invariably happen if the claw is chosen either too small or too large, either defect causing the force to expend itself in an improper direction. The pressure of the bolster always bruises the gum, and in many cases breaks off the edge of the alveolus, causing little flakes of bone to exfoliate for weeks after the operation, and this too in the most skillful hands. Sometimes the fracture of the alveolus is much more extensive, causing it to be broken away from four or five neighbouring teeth. This is always a serious injury, for in the event of hemorrhage it deprives us of the power of using the best remedy, namely, plugging the socket. The instances of the fracture of the jaw itself must be rare, and arise from great fragility of the bone.

DIRECTIONS FOR APPLYING THE KEY.

274. Having made choice of the key, the next point to determine is, on which side of the tooth you will apply the bolster. As a *general* rule for the both jaws, the bolster should go on the *inside* of the molar teeth. If, however, the molar is decayed on one side, the bolster must be placed on the decayed side, and if the tooth leans either in or out, it is better to place it on the side towards which the tooth leans. Having determined this

point, the next is to select a claw, and arrange in the key on its appropriate side. The selection of a claw is a matter of great nicety, for if it is too large it will allow the fulcrum to slip too low down on the alveolus, and will probably lead to the fracture of both it and the tooth, or of the claw, if it is weak. Whereas if it is too small, it will cause the top of the fulcrum to bear on the crown of the tooth and inevitably break it. These preliminaries arranged, and the gum lanced or freed from the neck of the tooth, the key must be applied to it, the claw being pushed with a finger of the left hand *as low as possible* on the neck and firmly held there. The fulcrum being now placed on the opposite side of the crown of the tooth near the neck, every effort must be made during the extracting movement to keep it from slipping down on the gum. The extracting effort is a *double* one, the movement being first to turn over the tooth from the claw towards the fulcrum, and as soon as it is felt to yield to lift it directly out of its socket by the fulcrum. The first action becomes merged in the second, and the result of the two is to remove the tooth with the least possible injury to the surrounding parts. Some operators acquire such dexterity, that the extraction is almost instantaneous, but the young operator must move slowly at first, and feel with his left forefinger what he is about. If the claw is felt to slip, the operator must stop and readjust his instrument.

275. Several forms of the key are given in Plate XVII., and in Plates XV. and XVI. its application to each jaw is shown. The reader is referred to the explanation of these plates for further remarks on this subject.

SECTION SECOND.

OF THE FORCEPS.

276. This in its simple form is an exceedingly useful and valuable instrument, and from the various modifications of which it is susceptible, it may be applied to any tooth or fragment of a tooth. The chief excellence which may be attributed to the forceps, besides the freedom which it enjoys from all the objections of the key, is that the operator can feel in which way the tooth is likely to come with the greatest ease and the least injury. A great mistake is usually made, particularly by country physicians, in the size of this instrument, thinking that the longer the forceps the easier the operation. This is an error. Much force is rarely required to extract any tooth, skill supplying its place in all cases. The forceps then should be as small as possible in proportion to the resistance they have to overcome, and in the plates accompanying this work, they are represented of their natural size, and with so much exactness, that an instrument maker in any part of the world can imitate them. In describing the varieties of this instrument

the simplest form will be first given, and the teeth enumerated to which each form is adapted. In a subsequent chapter directions for extracting each tooth will be given, with a reference to the proper instrument.

OF THE STRAIGHT FORCEPS.

277. The straight forceps present the simplest form of this instrument. When the jaws of the instrument are expanded sufficiently to grasp the appropriate tooth, the handles should be just so far apart as to afford an easy and firm grasp to the hand. The jaws are concave internally, and each terminate in two distinct points, which when the tooth is grasped and rotation attempted, keep their hold and do not cut off the neck of the tooth, an accident which is liable to happen if the edges are merely concave. They are figured in Plate XVIII. figure 5. Another form of jaw is necessary when the incisor teeth, particularly of the lower jaw, are much crowded. In this case the bifurcated jaw is too large to pass between the two contiguous teeth, and one jaw is terminated by a sharp point, as may be seen in Plate XX. figures 2 and 2, *a*. This point passes between the lateral teeth, and the tooth to be removed is held by three points instead of four. The straight forceps are chiefly used for the incisores and cuspidati, particularly of the upper jaw, though they may be used in the lower by standing behind the patient.

OF THE FORCEPS WITH CURVED BLADES.

278. In these forceps both blades are curved so as to change the direction of their force, at an angle which may even be as great as a right angle. This enables the operator to pass them directly backward into the mouth, and make them grasp the bicuspid and molar teeth. They are generally made strong, and the jaws shaped so as to adapt them to the larger classes of teeth. A form is shown in Plate XVIII. figure 2, which is adapted to the bicuspides and molares of the lower jaw. Another variety is found in Plate XIX. figures 4 and 4, *a*, in which the handle is curved to give a better hold. These last are particularly adapted to the lower molares on the left side. In Plate XVIII. figures 3 and 3, *a*, a modification of these forceps is seen, which is exceedingly well adapted to the molares of the upper jaw on the *left* side, or by having pairs, for either side. In these the jaws are unlike; one terminates in two points with a concavity between them, adapted to the long inner fang of those teeth, while the opposite jaw has three points and two concavities for the two outer fangs. There are two other forms which are altogether lighter and more

delicate, in which the beaks terminate in a sharp rounded edge. These are adapted to the extraction of snags and small irregular teeth. They are shown in Plate XIX. figures 3 and 3, *a*, and in Plate XX. figures 3 and 3, *a*. These last may be used to extract small bicuspides.

OF THE HAWK'S-BILL FORCEPS.

279. The third variety is curved also, but in a direction totally different from the last, and unlike them, the handles of the instrument participate in the curvature. In these forceps one beak is curved over the other like the upper mandible of a bird of prey, and is made longer than it. It is from this resemblance that the name *hawk's-bill* is derived. The jaws usually terminate each in two points when they are used for the smaller teeth, but when they are used for the molares of the lower jaw, they resemble very closely the bill of the hawk or parrot, and have but one point which fits in between the two fangs of those teeth. The first variety is seen in Plate XIX. figure 2, and the second in Plate XVIII. figure 4. Sometimes a lateral curve is given to the beaks as in Plate XIX. figures 1 and 1, *a*, which also adapts them to the bicuspides and molares of the upper jaw on the right side.

280. The hawk's-bill forceps have great power, and resemble the key in the direction of their force, possessing much more power to turn over the tooth than to lift it from its socket. The dentist must, therefore, guard the turning force and make a constant lifting effort, or he will break off the crown of the tooth.

OF FORCEPS BENT TWICE AT RIGHT ANGLES.

281. The object of this double flexure, is to enable the forceps to reach and grasp in a proper manner the posterior teeth, particularly the *dentes sapientiæ*. When the straight forceps are so bent, they are admirable for extracting the last molars of the upper jaw. This variety is exhibited in Plate XVIII. figure 1. Another pair is shown at Plate XIX. figures 5 and 5, *a*, for extracting fangs far back in the mouth, particularly in the upper jaw. When the hawk's-bill forceps are modified in this manner, and made large and strong, they are capable of removing any of the molares in either jaw, but for this purpose they must be made in pairs, right and left. One member of a pair is displayed in Plate XX. figures 1 and 1, *a*.

OF THE ELEVATOR.

282. This instrument is of very ancient date, and consists of a lever terminating in a sharp point. It must be made of well tempered steel, and kept sharp. Its utility is confined to snags, fangs and the wisdom teeth, particularly when small. It is used by pressing the point between the alveolus and the fang, and then pushing it against the fang, at the same time depressing the handle. The effect is to lift the fang out of its socket. It is *very apt to slip*, and consequently a finger or thumb of the left hand, well guarded by being wrapped with rag or buckskin, should be held in front of it, so as to receive the point if it should lose its hold. Many instances have occurred where the neglect of this precaution has led to the perforation of the patient's cheek, or a severe wound in the throat. Two forms of this instrument are figured, namely, in Plate XVIII. figure 6, and Plate XX. figures 5 and 5, *a*.

OF THE HOOK ELEVATOR.

283. To obviate the danger of perforating the cheek or injuring the palate by the elevator, this instrument was invented, which if it slips, comes out of the mouth and does no injury. It should, however, be well guarded by the thumb of the other hand. It is a kind of reversed elevator, and is used in the same way and for the same purposes, except that the operator has nothing but a *pull* to depend upon. The instrument is figured in Plate XX. figure 4.

OF THE CONICAL SCREW.

284. This instrument is particularly useful in the removal of fangs, upon which artificial teeth have been pivoted and worn for a long time. The fang in these cases is so thin that an attempt to grasp it on the outside with the forceps would inevitably fracture it; but the screw being forced into the cavity obtains a firm hold, and renders the extraction easy. The instrument in its best form is figured in Plate XX. figure 7. The thread of the screw must be made and kept very sharp.

OF THE GUM LANCET.

285. This instrument should for common use be narrow and pointed, and tempered to a blue or spring temper, to enable it to follow between the tooth and its alveolus; but for the wisdom teeth it should have two curvatures, as is shown in Plate XX. figures 6 and 6, *a*. This low temper prevents the blade breaking, but is too soft to keep sharp long. A small whetstone will soon remedy this evil.

SECTION THIRD.

OF THE EXTRACTION OF THE INDIVIDUAL TEETH.

286. For the better instruction of the tyro, I propose giving minute directions for the removal of each class of teeth, with a reference to the proper instruments. It is to be premised that the tooth, *in all cases*, should be separated from the gum and the alveolus. This should never be omitted, except in the case of the temporary teeth, when it seems to be unnecessary; and great care is to be taken to keep the lancet as close as possible to the tooth, and to cut as deep as possible, so as to cut the ligamentous fibres alluded to in Paragraph 145. In the case of the molares, these fibres are the most numerous and strongest between the teeth, and the lancet should be pushed boldly in that direction, as it will be found to facilitate *amazingly* the removal of the tooth.

EXTRACTION OF THE UPPER INCISORS.

287. These teeth may be best removed by means of the straight forceps, (see Plate XVIII. figure 5,) the operator standing in front of the patient, on his right. A firm grasp should be taken of the neck of the tooth, back and front, and as their fangs are conical and rounded, an alternate rotating motion, combined with a downward pull, will soon start them from their sockets.

EXTRACTION OF THE LOWER INCISORS.

288. These are usually removed with the small hawk's-bill forceps, (see Plate XIX. figure 2,) the operator standing in front. A grasp being taken, back and front, the tooth should be moved backwards and forwards, combined with a lifting effort. As the roots of these teeth are flat on their sides they cannot be rotated. A better mode of extracting them is to get behind the patient on a large stool, made for the purpose, and extract them by means of the straight forceps, (Plate XVIII. figure 5); the same direction of the applied force being adopted. If they are much crowded, the small forceps (see Plate XX. figure 2 and 2, *a*,) must be used, the single point being on the crowded side. If a lower incisor is much out of the range in front, and its two neighbours almost close up the space behind it, the forceps, Plate XVIII. figure 2, may be used to grasp the tooth in front, by placing the point of its jaws on either side, and *pushing* out the teeth from below.

289. The incisors never require the key.

EXTRACTION OF THE CUSPIDATI.

290. These teeth may be extracted by the same instruments, and in the same manner as the incisores, but they require more force to dislodge them, as their fangs are both larger and longer. In removing those of the lower jaw, it is particularly recommended to stand behind the patient, and use the straight forceps, for their roots being more rounded than those of the lower incisors, the operator can rotate them a little, a manœuvre which it is impossible to execute with the hawk's-bill forceps.

EXTRACTION OF THE UPPER BICUSPIDATI.

291. These teeth may generally be taken out with the straight forceps (see Plate XVIII. figure 5), particularly if a hook is formed to one of the handles, as in figure 3 of the same plate. They must be seized as high up on the neck under the gum, as it is possible to push the forceps, and a steady pull, combined with a motion of the handles inwards and outwards will rarely fail to remove the tooth with ease and safety. If the operator stands

behind the patient he may use the hawk's-bill, (Plate XIX. figure 2,) for the teeth on the right side, and for those on the left the bent forceps figured Plate XX. 3 and 3, *a*. If the key is adapted to any class of teeth, however, it is the one under consideration and their opposites of the lower jaw, and many operators will doubtless continue to use it, particularly when the crown is much decayed.

EXTRACTION OF THE LOWER BICUSPIDATI.

292. The lower bicuspidati are readily extracted by means of the forceps, (Plate XVIII. figure 2.) If the operator prefers standing behind his patient, he may take out those of the left side by the use of the forceps, (Plate XIX. figure 4 and 4, *a*,) which when properly grasped possess great power. The hand must be held under the lift, the fingers being on the side of the hook, the effort is then made from the elbow, and gives the dentist great power.

293. The same movement must be made in this as in the case of the upper jaw.

EXTRACTION OF THE FIRST AND SECOND MOLARS, UPPER JAW.

294. These teeth are very firmly set, and generally tempt the operator to use the key, but they can be removed with equal certainty and much less injury by the forceps. The operator standing on the right of the patient, in front, grasps the tooth, after the preliminary lancing, high up on its neck, pushing the instrument well under the gum with either of the pairs of forceps, one of which is figured in Plate XVIII. figure 3. They are made in pairs to suit both sides of the mouth. The pair represented is for the left side, the jaw having two teeth being placed on the inside of the mouth, and that with three on the outside. Having grasped the handles tight enough to prevent the instrument slipping, but not carrying the pressure too far for fear of snapping off the crown, a steady pull is to be commenced, accompanied with a movement of the handles at first outwardly and then inwardly. The operator will now feel on which side the tooth will yield first, and having discovered this, he continues the pull without changing the position of his hand, and the tooth follows regularly and steadily.

295. The upper molars of the right side may also be very well taken out by means of the forceps, (Plate XVIII. figure 4, or XIX. figure 1.) In this case the operator stands on his stool behind. One of the members of the pair bent twice at right angles, may also be used for any of them, (Plate XX. figure 1 and 1, *a*.)

EXTRACTION OF THE FIRST AND SECOND MOLARS, LOWER JAW.

296. If the operator stands in front, these teeth may be removed from the right side by means of the bent forceps, (Plate XVIII. figure 2,) or the double-bent hawk's-bill, (Plate XX. figure 1.) Those on the left side may either be taken out with the same instruments, or by standing behind, the hooked pair (Plate XIX. figure 4) may be used with great advantage. The pointed hawk's-bill shown in Plate XIX. figures 1 and 1, *a*, is also well adapted to the removal of the teeth under consideration, for by a reference to Plate VI. figures 14 and 15, it will be seen that the points will pass in between the fangs and get an exceedingly firm hold. They are particularly useful when the crown is decayed almost entirely down to the gum.

297. The same direction must be given to the force as in the case of their congeners of the upper jaw.

EXTRACTION OF THE DENTES SAPIENTIÆ, UPPER JAW.

298. These teeth are sometimes very readily removed, but at others the points of the fang are so bent and contorted, that they *must* be broken in the effort. (See Plate VI. figures 8 and 61.)

299. The same rule as to the application of the direction of the force, is to be adopted here, which was recommended in the sections on extraction of the first and second molars. The back of the chair must be lowered, so that the patient is almost recumbent, which facilitates the getting at the teeth materially.

300. The forceps (XVIII. figure 1,) have been contrived purposely for these teeth and are admirably adapted to them, but if the operator does not possess them, the double-bent hawk's bill (Plate XX. figure 1) will answer very well.

EXTRACTION OF THE DENTES SAPIENTIÆ, LOWER JAW.

301. If the mouth can be opened wide enough, the best forceps for these teeth are those figured at Plate XVIII. figure 2; but if this is not possible, those shown at Plate XX.

figure 3, or figure 1, may be substituted. When these teeth come out irregularly, so that there is not room between the ramus of the jaw and the second molar for them to rise, the crown should be crushed by the pair (Plate XVIII. figure 4) which are quite strong enough for this purpose, and the fang taken out subsequently, either with the forceps (Plate XIX. figure 3) or one of the elevators, (Plate XVIII. figure 6, and Plate XX. figures 4 and 5.)

EXTRACTION OF FANGS AND SNAGS.

302. The preliminary operation of lancing is as much if not more required in these cases as where the teeth are perfect. They are generally removed with one of the elevators, the point of which is insinuated between the alveolus and the snag, and a fulcrum being made of the top or side of a neighbouring tooth, or the thumb of the operator's right hand, the handle is suddenly depressed, whilst the push is continued, and if the instrument *does not slip*, the fang usually comes out.

303. But these instruments are very liable to slip, and if not well guarded by the finger or thumb of the operator's left hand, wrapped with muslin, may pass through the patient's cheek, or inflict a serious and troublesome wound on the palate. Wherever, therefore, a delicate pair of forceps can be used, they should be preferred. Two pair are shown in Plate XIX. figures 3 and 5, which are adapted to any position of the tooth. When the fang of an incisor or cuspid has been used to pivot an artificial tooth upon, and a necessity arises for its removal, the conical screw (Plate XX. figure 7) will be found of great service, as the fang is so thin that it would crush under the grasp of the forceps or pressure of the elevator. This instrument must be screwed into the cavity in the fang until it obtains a secure hold, when the fang may be pulled directly out.

SECTION FOURTH.

OF ACCIDENTS ARISING FROM EXTRACTION.

304. The only accidents of importance which arise in consequence of extracting the teeth are *Fracture* to a greater or less extent of the alveolus, or jaw, and *Hæmorrhage*.

FRACTURE OF THE ALVEOLUS.

305. Fracture of the alveolus to a small extent is a very common result of the use of the key, even in the most skilful hands, and it may even be produced by the forceps, when the fang of the tooth is enlarged at its extremity, or when there are several fangs and they spread very much. The only inconvenience which attends this mild form of the accident, is the exfoliation of small spiculæ of bone, which keep up irritation for several days or weeks. The fracture is not always confined to the alveolus, however, for many horrible cases are related by the writers on dental surgery, where large portions of the alveolus were broken from the side of as many as six teeth, producing great suffering and resulting in immediate deformity; but as these cases are in a great measure removed from the province of the dentist, I will not dwell upon them here. It is a common thing to hear of jaw bones being fractured, but it is to be doubted whether such an occurrence as a complete fracture of the lower maxilla ever arose from the extraction of a tooth.

HÆMORRHAGE.

306. This usually arises from the rupture of the artery which supplies the dental pulp, and occurs in the following way; the artery just before it penetrates the fang, is enclosed in a little bony tube, which it exactly fits and to which it adheres by its external coat. It passes directly from the end of this little tube, (which is at the bottom of the socket,) to the aperture in the end of the fang. Now when a tooth is extracted, and at the moment it first moves, this artery is drawn out or elongated for a single instant before it gives way. This traction suffers usually to break up the adhesion between its outer coat and the bony tube, and it *retracts* within its orifice and soon ceases to shed blood; but in some cases this adhesion is not destroyed, and the artery being incapable of retracting, sheds blood freely and continuously. When this occurs the socket does not bleed faster than usual at first, but it is continuous, and if not remedied, might go on to a fatal termination.

307. Other cases, however, arise from a different cause; a state of the general system which is commonly known as a *hæmorrhagic diathesis.* This *diathesis* or tendency to shed blood from slight injuries, is very frequently hereditary and lasts for life, while at others it is merely temporary, and is the effect of long continued ill health, or a state of the system brought about by unfavourable circumstances, such as confinement, bad diet, salt provisions, &c. &c.

308. In those persons in whom this predisposition is hereditary, the slightest injury will

cause a very great and sometimes fatal loss of blood, and this condition is very difficult to remedy. When the dentist is aware of its existence, no consideration should induce him to remove a tooth, as the death of his patient might follow the operation.

309. Cases of death from the extraction of the teeth, in maniacs and young persons, have arisen also from the uncontrollable habit of sucking the bleeding cavity. A partial vacuum being thus formed in the mouth, the bleeding is encouraged in the most perfect manner, and the flow fairly set up, becomes in some measure a matter of habit, and is extremely difficult to arrest.

TREATMENT OF HÆMORRHAGE.

310. When undue hæmorrhage occurs from the socket of the extracted tooth, it is most common to apply to it some styptic or astringent substance, either in the form of a wash for the mouth or an application to the bleeding part. The most commonly used of these styptics are the following:—Powdered galls, alum, blue vitriol or sulphate of copper, muriated tincture of iron, spirits of turpentine and creosote.

311. These substances are applied by means of a lock of cotton to the part, and surmounted with a compress of cotton, which is then bitten upon by the opposite tooth so as to make a slight compression. This plan very often succeeds in slight cases.

312. There is a substance which was first introduced to the notice of the profession by Dr. W. S. W. Ruschenberger, U. S. N., which is obtained in South America, and doubtless would prove of value in these cases. It is the leaf of the plant called *matico*, or soldier's weed, from the fact of its being in common use for the suppression of bleeding from recent wounds. It is used by applying the leaf to the wounded part. This herb was introduced into Liverpool by Dr. Jefferys at a subsequent date, and we find by a reference to the London and Edinburgh Monthly Journal of Medical Science, for August, 1843, page 737, that upon being subjected to trial in the dried state, it fully confirmed the account of its virtues. In several trials made by Dr. R. and myself, we had every reason to be satisfied with its powers. As, however, this herb is still a rarity, it would be well to possess a styptic of considerable power and of easy access. I would recommend the following, confident that it will be found tenfold more powerful than any now in ordinary use. Cause some alcohol to dissolve as much of the following substances as it is capable of doing, so that it may be a saturated tincture, namely;—ergot or secale cornutum, and gallic acid, then add about one-fourth of creosote, by measure. This tincture may be applied as above mentioned, or may be used to saturate the lint used in plugging the cavity, should that measure become necessary. Ergot in the form of a watery solution may be used with success in many cases, as a gargle or mouth wash, particularly when the hæmorrhage comes from the gums. Nitrate of silver has been tried very often and with gratifying

success; it is a measure which should never be forgotten or neglected. It is used in the solid form by cutting a stick of it to a long point, which is to be pushed into the socket and held there for a few moments. It gives very little pain, and generally arrests the bleeding promptly and completely. I could give many cases of the success of this measure, but this would occupy unnecessary space. I refer the reader, however, to a paper by Mr. Ray on this subject, in the London Lancet for March 6, 1841, p. 824.

313. Plugging the socket is, however, the only certain means for arresting a profuse hæmorrhage from the artery at its bottom. This is best performed by taking a long slip of linen rag, which may be advantageously saturated with the styptic recommended above, or a solution of ergot in water, or if it can be obtained, a tea made of the *matico*, and by means of a large plugger, firmly pressed into the socket until it is full. If well done it requires no compress to be placed over it, but if the operator fears that it will lose its place, he may apply one, and shutting the mouth retain it by means of a bandage, which shall prevent the jaw from opening. The bandage may be removed in twenty-four hours, but the plug should be suffered to retain its place in the socket, until loosened by the suppurative process. Other modes of plugging the socket have been recommended, and are worthy of notice; one is the reinsertion of the tooth just extracted, which is suffered to remain until the socket becomes sore, indicating a slight inflammation, when it may be removed.

314. Another plan, which at least has the merit of novelty, is to fill the cavity with plaster of Paris, mixed to a good consistence with water, and hold it in the socket by the end of a finger until it hardens. Mr. Roberts, of Edinburgh, relates a successful case in which this plan was adopted. (See London Medical Gazette, May 6, 1842, page 269.)

315. It must however be stated, (and this furnishes a strong argument in favour of the use of the forceps for extraction,) that if the socket is not perfect, all these measures will fail, for the plug will press open any fracture made in the alveolus, and thus give a freer exit to the flowing blood.

316. A very important measure, particularly in young subjects or maniacs, is to interpose something between the jaw which shall prevent the entire closure of the mouth. In this way the patient will be rendered incapable of producing a vacuum in the mouth by sucking.

317. When the bleeding is caused by that state of the system called the hæmorrhagic diathesis, the local treatment above directed will do but little good, unless assisted by general or constitutional treatment, and for the purpose of applying this scientifically, we must study the condition both of the blood and the capillary vessels of the part from which the hæmorrhage proceeds.

318. The blood in these cases has been found to be in the condition commonly called poor and watery, that is, its serum or fluid predominates, and its fibrin or that part which forms the clot when freshly drawn blood is suffered to stand, is deficient. From this results an inability to form a firm clot or coagulum, which is nature's mode of stopping hæmorrhage. Now is it possible to remedy this condition by medicine? There are two modes of accomplishing this; one is to deprive the mass of blood of part of its serum, and the other to

increase the coagulability of the blood by the addition of some saline ingredient to its mass. The administration of sulphate of soda, muriate of soda or chlorate of potassa, or a mixture of these salts, will to a certain extent fulfil both these indications, and should always be tried in these cases. The remedy diminishes the amount of serum by the free watery purging which it produces, and the portion absorbed and mixed with the blood, tends to confer a power of forming a firm clot not possessed before. A good proportion of these salts is as follows:—

Take of Sulphate of Soda, one ounce.
Muriate of Soda, half an ounce.
Chlorate of Potash, one drachm.

Mix and divide into six parts, one of which may be administered every hour or two until free purging is produced.

319. The condition of the capillary vessels of the part is very curious, they are much dilated, and their parietes thereby thinned and thus liable to give way.

320. This may arise from a diseased condition of the vessels themselves, or from a turgid or congested state of them, produced by the condition of the blood, for it was found by Poisseuille, that a certain amount of stickiness or viscidity favoured the passage of fluids in capillary tubes; now as the blood in these cases has its viscidity diminished, it is retarded in the capillary vessels, and gives rise to a congested condition of them extremely favourable to the production of hæmorrhage.

321. This dilated condition of the vessels of the part may certainly be remedied to a certain extent, by the application of some of the styptic remedies mentioned in Paragraph 312. It seems probable that the most common general remedy for hæmorrhage, viz. opium and acetate of lead, acts in this way; though in consequence of sulphate of soda being incompatible with the acetate of lead, these remedies should never be given simultaneously, as they would destroy each other's action. Ergot, however, will produce a contraction of the capillary system when administered internally, and does not seem to present any incompatibility with the saline remedies above noted. It may be given in doses of from five to twenty grains three times a day, taking care never to recommend it in the case of a pregnant female. Its external or local use has been already alluded to.

SECTION FIFTH.

OF EXCISION OF THE TEETH.

322. This operation, which consists in the snapping off a tooth at its neck, by means of a pair of sharp forceps, called excising forceps, was at one time highly approved of, but in

consequence of the irritation of the fang which is left, and the necessity which usually occurs for its subsequent removal, the operation has now fallen into disrepute.

323. I can conceive, however, of one case in which it may be useful, namely, when there exists an hereditary predisposition to hæmorrhage, this operation would by destroying the pulp relieve the patient from much suffering, and not expose him to the danger of excessive bleeding.

CHAPTER ELEVENTH.

IRREGULARITY OF THE TEETH.

324. In treating of irregularity of the teeth, I shall confine myself almost exclusively to irregularity of the permanent teeth, because it is exceedingly rare in the temporary set, and when it does occur, is of little consequence except so far as it affects their successors. Irregularity may be divided as follows:—1. Irregularity of Position and Direction. 2. Irregularity of Formation and Shape. 3. Irregularity of Number.

IRREGULARITY OF POSITION AND DIRECTION.

325. The classes of teeth most liable to be affected with irregularity, are the incisors and cuspidati, the only teeth which possess *itinera dentium*. Although the bicuspid occasionally rise improperly, the first and second molars are rarely the subjects of irregularity, for the reason that, like the temporary teeth, they meet with no obstacle in rising through the gum. A very curious instance, however, of an improper position of a second molar is figured in Plate XI. figure 14. The specimen from which it is taken is in the Anatomical Museum of the University of Pennsylvania. A tumour having been observed on the side of the jaw and the second molar being wanting, the bone was chiselled off and the tooth found imbedded as represented. No history of the individual could be obtained.

326. The *dentes sapientiæ*, however, frequently make their appearance in an irregular manner, in consequence of the small space which is left for them between the second molar and the ramus of the jaw.

327. When the bicuspides are the subject of irregularity, they either turn inwards towards the tongue, or outwards towards the cheek, the amount of derangement seldom being great. An example of great deviation in the position of one of these teeth is shown in Plate XI. figure 7. It assumed this curious position in consequence of the temporary molar just above it retaining its position with unusual tenacity, favoured perhaps by some accident to its gubernaculum.

328. The most simple form of irregularity in the cuspidati, consists in an obliquity of position in their sockets, the face of the tooth turning either to the right or left, and to a greater or less extent, according to the want of room in the dental arch. Another deviation of these teeth is their projection beyond their neighbours, as in Plate XI. figures 2 and 8. This malposition arises from a total want of room for them in the dental arch, and is consequently exceedingly difficult to remedy. It gives rise to much inconvenience, by ulcerating the inside of the lips opposite to them, and always cutting deeply upon the reception of a blow or a fall on the face.

329. Irregularity is by far more common in the incisors than in any other class, and assumes a greater variety of forms; the deviation extending from simple obliquity to the most outré and unexpected situation of the tooth. It is moreover more important as it involves greater deformity, and excites the attention much more than any other form.

330. It may be remarked that irregularity in the incisors, especially when it is confined to one or both teeth, is far more common in the upper than in the under jaw. The simplest and most common derangement is an obliquity of the lateral incisors, which is sometimes so great as to cause them to present their edge outwards; in this case the central incisors are more or less crowded together, and occasionally form an angle with each other, the apex of which points either inwards or outwards, but is most common in the latter direction. Another deviation is the projecting backwards or forwards of a single tooth, generally one of the central incisors, which in some cases deviates so far from its proper direction as to grow directly inwards towards the tongue, or outwards, as if it would perforate the upper lip. In a third case, the incisors come down in their proper direction, but some distance too far back, so as to be in the roof of the mouth; this usually happens to the lateral incisors. A great disadvantage attends these latter deviations, for when the jaw closes the under teeth shut behind all, except the irregular one, and is thus enclosed or pinched in an angle, which wholly prevents the lateral or grinding motion of the jaw described in Paragraph 64. (See Plate XI. figure 3, for a representation of this condition, also same plate, figure 10.) Cases are mentioned by M. Delabarre of transposition of the lateral and central incisors, the centrals becoming lateral and *vice versa*. The true state of the case was, probably, that the lateral incisors grew wider and the centrals narrower than usual, so that the appearance of transposition was presented.

331. The incisors of the lower jaw are rarely so much or so frequently affected as their congeners of the upper, and their irregularity is not so much seen, consequently the dentist is rarely called upon to remedy it.

332. Like the incisors of the upper jaw, these teeth are most subject to obliquity, which is sometimes relieved by the tooth most affected coming out in front of the others, and losing its place in the dental arch. In this case the tooth causes great attrition upon the opponent in the upper jaw, and usually demands prompt removal. The irregularity of the lower incisors, although it does not produce as much deformity as that affecting the upper row, interferes materially with the distinctness of the utterance and enunciation of

words, and sometimes is the sole cause of lisping. This form of irregularity is represented at Plate XI. figure 9.

333. The forms of irregularity treated of so far, are those which affect individual teeth, but it becomes a very important subject of consideration to the dental surgeon, when he is presented with deviations affecting the whole of the front set, upon which the shape of the face and the speech of the individual so much depend. The most common deviation affecting the whole mouth is the projection of the lower jaw over the upper, so as to produce a *false close* as it is called. By referring to Plate II. figure 1, the *true close* will be seen, and it will be found that the upper teeth overlap the under ones considerably, and that at the same time the last molares are exactly opposite.

334. By reference to Plate IV. figures 1 and 3, it will be seen also that the distance between the lines enclosing the incisors, cuspid and bicuspid of the upper jaw (figure 1) is greater than those enclosing the same teeth in the lower, (figure 3.) These figures, which exhibit the regular or normal arrangement, also show the cause of it in the preponderance in size of all these teeth in the upper, over those of the lower jaw. Now, when this deformity (*false close*) exists, the relative size of the teeth is not altered, consequently the lower jaw becomes deformed, is elongated and its angle rendered very obtuse. Any one understanding the principle of the lever, will see that great loss of power in the muscles of mastication must result, and to this is added a loss of the lateral motion of the jaw, so that an individual affected in this way almost loses the power of masticating food properly. (See Plate XI. figure 12, for this deformity.) Occasionally the want of room in the upper dental arch is so remarkable, that the teeth are forced to arrange themselves in two rows, and the lower set closes in between them. The mouth in these cases, is remarkably small, and there seems to be a congenital defect in the size of the jaw, the appearance produced being very curious. I have at present under cognizance two cases, one a girl of sixteen, and the other a gentleman of at least forty-five, whose children, however, fail to exhibit some defect. The appearance presented is somewhat like Plate X. figure 23, which is taken from Fox, and was produced by the two conical supernumerary teeth starting out between the central and lateral incisors. Supernumerary teeth would be very likely to produce this result in any case, but there is in Philadelphia a negro man, who has eighteen teeth in the upper jaw, all regular and quite perfect. He is employed in selling canes, &c. about the streets, and is quite proud of his grinders. A form of deviation which can hardly be called irregularity exists occasionally, being most frequently found in the negro, which consists in a projection of the whole set of anterior teeth in the upper jaw, so that the lip with difficulty covers them, arising from a want of room in the alveoli at the end of the fangs, which being crowded together cause the crowns to project, even at an angle of forty-five degrees with the perpendicular when the individual is erect.

CAUSES OF IRREGULARITY.

335. The causes of irregularity will be best understood by referring to the cause of the *regularity* of the teeth in the perfectly formed mouth. The temporary teeth and the permanent molares rise and occupy their places because their germs are immediately under the spot from which they emerge. The primordial law which placed their germs in that situation, has been too little studied to enable us to attempt to explain it. It is enough for us at present to know that it exists, and that for every perfect child born, there are fifty-two germs which are destined to be converted into as many teeth, and in those few rare cases in which a third set make their appearance, this number is exceeded. The permanent incisors, cuspid, and bicuspid, in consequence of their position behind and beneath the temporary set, do not enjoy equal facility in making their way into their appropriate places. Their *gubernacula* leading through their itinera, (see Paragraph 170,) serve to guide them, but this may be lost in early life, either by ulceration or by imprudent and improper lancing of the gums of the infant to favour the first dentition. When this simple and highly useful operation is performed, the lancet should be kept to the front of the tooth, so that if it slips in too deeply, it may not cut off this important filament.

336. There is another cause of retardation of these classes of permanent teeth in the presence of their predecessors of the temporary set. Usually the crown of the rising tooth presses upon the end of the fang of the temporary above it, and first cutting off its vascular supply by obstructing the artery, insures its death. The surrounding tissues then exert their absorptive power, and the fang of the milk tooth is shortened as its permanent successor rises. But if the rising tooth fails, from a slight change of direction, to impinge upon the artery of the milk tooth above it, the latter preserves its vitality and is not subjected to absorption. In this case if it is not removed by the dentist, it forces the permanent tooth to pursue some other course and thus produces irregularity.

337. By far the most prolific cause of irregularity, however, is the want of room in the dental arches. This arises sometimes from a congenital defect, but most commonly from early decay and loss of the temporary teeth, which failing to keep up the alveoli, enables the jaw to contract and thus afford too little room for the permanent set. It may be remarked here, that the permanent teeth which replace the temporary set require no more room than they occupied, as may be seen at Plate IV. figures 1, 2, 3 and 4, for although the incisors are larger, the bicuspides are smaller, than their predecessors. These remarks afford an important hint to the dentist to preserve the temporaries so long, and *only so long*, as they interfere with the permanent set, taking care to remove them the moment that the permanent is found to be assuming a wrong direction.

TREATMENT OF THE FIRST FORM OF IRREGULARITY.

338. In commencing an account of the treatment of these deviations, it may be well to remark that the age of the patient is a most important item to be considered in making up an opinion as to the probable success of surgical interference. Previous to the age of fifteen the remedies are very apt to prove successful, but after that the treatment becomes progressively more tedious, difficult and uncertain. If pressure is made upon one side of a tooth at any period previous to the completion of the ossification of the skeleton, it will produce absorption of that side of the alveolus against which the fang is made to press, being attended with a deposition of bone on the opposite side, *pari passu*, so that the tooth slowly changes its position without ever becoming loose in its socket. To accomplish this process well, the periostea between the fang and socket must be in a healthy condition. Now in advanced life the process of ossification is limited to the repair of the skeleton, which power becomes more feeble as life advances. The periosteum also becomes thinner and is partially ossified. If under these circumstances any effort should be made to change the position of a tooth, which is not exquisitely regular and gradual, it must loosen the tooth in its socket, and give rise to morbid action in its periosteal investment. Having taken the age of the patient into consideration, and determined to proceed, the operator must next inquire into the causes producing the deviation from the normal state, and begin by removing them when practicable.

339. The successful treatment of irregularity must also depend upon both the extent and nature of the deviation, almost every variety requiring either a modification or total change of treatment.

340. When the incisors of the upper jaw come out irregularly, particularly when they are behind their temporary antecedents, these must be removed to make room, and even when the deviation extends only to the central incisors the four temporaries require removal, for the permanents being broader than their analogues of the milk set, there will not be room enough made by their removal alone. After the required room is thus obtained, pressure made by means of a tooth-brush handle, or a hickory stick, and perseveringly applied by the patient, will soon cause the affected teeth to take a correct position. Constant pressure with the thumb even, will suffice in many cases. When this deviation occurs to the incisors of the lower jaw, it will suffice to remove the temporaries, as the tongue of the little patient will push them forwards into their proper places.

341. When the cuspidati come out improperly, they are generally found in front of the other teeth, and present two varieties depending upon the distance between the lateral incisor and the first bicuspid. (See Plate XI. figures 2 and 8.) In one case these teeth are nearly in contact, and in the other have an interval between them almost large enough to accommodate the deviating tooth. The proper treatment in the former case is to

remove the first bicuspids, and allow the cuspid to fall back into its place, which it readily does without much assistance. In the latter case it would be better to extract the second bicuspid, and approximate the first bicuspid and first molar by silk thread tied around their necks and frequently renewed. If in either of these cases the lateral incisor should be decayed, it would be preferable to remove it, although the patient would then have what is called a dog's mouth.

342. One or more of the incisors of the upper jaw are liable to grow directly inwards towards the tongue, and the deviation is sometimes so great that the use of a tooth-brush handle, as described in Paragraph 340, would not suffice to restore it to its proper place. In such a case a plate should be made to fit the lower row with an offset which will pass behind the deviating tooth and prevent the jaw from closing until it has coaxed it into its place. This it does by presenting to it an inclined plane acting in all positions as a lever to force the tooth forward. Two forms of these plates are shown on Plate XI. figures 5 and 6, and the mode of applying and attaching it on the same plate, figure 4.

343. One of the most difficult forms to remedy of irregularity in the incisors, is obliquity arising from a want of room for their normal arrangement. As this obliquity gives rise to much deformity, particularly in the upper jaw, it is important to pay great attention to its treatment. This must be commenced by making room for the assumption of its place by the oblique tooth. A file may be passed between each of the front teeth, taking care not to cut through the whole thickness of the enamel, and to carry the file well under the gum so as to clear the teeth completely. If this does not give room enough, pieces of gum elastic must be squeezed in between the teeth and renewed every day or two. Its elasticity, aided by the warmth and moisture of the mouth, will soon increase the space so that the subsequent part of the process may be commenced. Occasionally this mode of applying gum elastic will answer without filing, which should always be avoided if practicable. This plan of expanding the dental arch and thus separating the teeth will not answer as well for the lower jaw, because its size is limited by that of the upper jaw, and if filing should not afford room one of them may be extracted, which will rarely excite observation.

344. Having by these or any other means obtained room, a cast must be taken of the oblique tooth, and a gold cap made to fit it accurately. To this cap a bar must be firmly attached so as to pass in front of the two contiguous teeth, on the side towards which the tooth is to be turned. This bar must stand up from the teeth at its free extremity, and from it a ligature must be carried between them and back to a firm tooth, as a bicuspid, or better, a molar, around which it must be secured. This ligature must be tightened daily, so as to act upon the end of the lever and thus turn the tooth gradually into a proper position. If the tooth is very oblique, another lever may be placed on the inside of the mouth and inclined in the opposite direction, which will double the power applied to the irregular tooth. If two teeth are affected, they must be acted upon one at a time, an interval being allowed after the first one is regulated to allow it to become secure in its new position, before any attempt is made to rectify the second.

345. When a lower incisor is either very oblique or is pushed out of the line in front

of its fellows, it should be promptly removed, as if left it will materially injure the opposite tooth in the upper jaw.

346. In those cases in which the teeth have come out in an improper position the treatment must be adopted which is applicable to the projection of the lower jaw beyond the upper, for the principle involved is precisely the same. The first step is to keep the jaws separate, so that the teeth to be rectified should not meet or pass each other. This may be done by placing pieces of ivory between some of the back teeth, or by capping them with a gold cap made to fit; this latter plan is the most modern and is considered an improvement, but as ivory is pleasanter to bite on than gold, this is to be doubted. Having insured the separation of the jaws by either of these plans, a gold bar must be made to fasten to the first or second molars firmly, and form an arch either in front of or behind the teeth, as the case may be. Two modes are adopted to secure the ends of the bar to the back teeth, one is by means of ligatures, the other by clasps surrounding their necks, such as are used to secure artificial teeth. It is needless to say that the last plan is the best. If the teeth are to be drawn back the bar must be placed behind, and in the contrary case in front. In both cases great advantage is derived from shaping it to fit the regular members of the row, and sit close to all but those to be rectified. Ligatures must then be passed around the necks of the offending teeth, and drawn tight from them to the bar, which may have holes made in it for their security if desired; these should be tightened daily, at which time the bar must be taken off and cleaned thoroughly. A figure of one of these bars, from Fox, is given in Plate XI. figure 11. The material for the ligature is of some importance; they may be made of saddler's silk or Indian twist, but the strongest substance that can be used is sea-grass fishing line, which can be freely obtained and of various sizes. Some writers recommend metal loops secured to the bar by screws, but these are more difficult to make, and must irritate the lips and cheeks of the patient. When the bicuspid teeth make their appearance in an irregular position and produce irritation either of the cheek or tongue, they should be extracted. If, however, they produce no inconvenience they may be suffered to remain.

347. The first and second molares are scarcely ever irregular, and if it should occur, the judgment of the operator must be relied on to do the best which the case may admit. No attempt, however, can be successful to cause these teeth to change their places to any extent.

348. Any irregularity in the *dentes sapientiæ* can only be remedied by extraction, which is not always easy, for it frequently happens that the crown of the wisdom tooth presents directly forwards, and impinges upon the side of the crown of the second molar, causing its rapid and premature decay. If this decay has gone far, the extraction of this tooth must precede that of the dens sapientiæ.

349. Other plans of treating these deviations will occur to a man of mechanical ingenuity, but we trust that the above will be found sufficient for the vast majority of cases. I have added to this chapter some cases which were furnished me by Mr. Parker, in one of which he met with brilliant success, at a period of life usually considered too late for the successful intervention of art.

CASE I.

350. Miss A., a young lady about twenty or twenty-one years of age, had the four inferior incisors projecting beyond the superior. She was very anxious to have them altered, as it not only spoiled the appearance of her mouth, but the cuspidati of the upper jaw coming in contact with the bicuspides of the lower, the molars of both were of very little use. As there was a space of at least one-eighth of an inch between them, I gave her little encouragement, but as her anxiety was so great I agreed to do what I could towards altering them. I found it was necessary to extract one of the lower central incisors, which was readily consented to. I then made a very strong band, and as the molar teeth were very firm, I clasped it to them. The pieces of ivory which were attached to the band had to be made very thick, on account of the molar teeth being so far apart, which at first was somewhat inconvenient. She had the ligature removed every day for about two weeks; afterwards every two days for about two months. The only inconvenience the band caused was great difficulty in speaking at first; but as that gradually wore off, it gave her very little trouble, and her under teeth were brought quite within the arch of the upper, and on the band being removed, the molars came in contact with each other, so that (to her very great satisfaction) the close was perfect.

CASE II.

351. Miss S. A., sister to the young lady just mentioned, having her teeth pretty much in the same condition, after seeing her sister so much improved in appearance, as well as having her back teeth made to be very useful by the operation, applied to me to have her teeth forced in their place. She being at that time about seventeen years of age, I readily undertook the operation. As she objected to having any of her lower teeth extracted I separated them with a file, as the only alternative, and proceeded as in the former case. I had very little difficulty in causing the lower teeth to take their proper position, which they did in less than two months, (perhaps not more than six weeks,) but one of the lateral incisors of the upper jaw being turned obliquely, rested on the incisors below. I therefore applied the lever cap, and after continuing it for nearly two months longer, had the satisfaction of bringing it round in the line of the other teeth.

CASE III.

352. Miss T., a young lady, having one of the upper central incisors very much turned, and one of the lower lateral incisors projecting much beyond the other teeth, called on me for the purpose of having her teeth attended to, as the upper tooth was very much worn away by coming in contact with the lower one; I proposed extracting the projecting tooth as a partial remedy, which was done; but as part of the upper tooth still came in contact, and was likely to be much injured if it was suffered to remain in that state, I recommended the band and ligatures, but she would not undergo the operation. She at that time was about nineteen years of age. She continued to call on me for various operations on her teeth for two years; the upper tooth being much more worn by that time, she became anxious to have the evil remedied, if possible; I was obliged to file the teeth on both sides, as they were much crowded; I applied the gum-elastic pressure for some time and followed it by the lever; she could not have the ivories between her teeth on account of her being an attendant in a store, and of course much exposed to strangers, and obliged to talk to them, which she could not have done very well for some time; however, I tied the lower teeth, from one to the other, with strong silk, until they were brought under the upper teeth, at the same time applying the band to the upper; I also gave her a piece of hickory with a notch filed in the end, and recommended her to endeavour to turn the tooth by that means: however, when the point of the upper tooth was brought over the lower ones, she was very careful not to suffer it to close within them, and when alone would press it constantly with the lower teeth. It has settled completely in its place. This was by far the most difficult operation of the kind, and took much longer time than any I ever undertook, which shows the necessity of attending to all such cases very early, in proof of which I beg leave to give one which was taken at the proper age.

CASE IV.

353. Miss P., a girl about eleven years of age, was brought by her mother for the purpose of having some of her teeth extracted. On examining her mouth, I discovered that one of the central incisors of the upper jaw was much within the lower teeth, while the other, on the contrary, was forced considerably outward; the bicuspides had come down, and two of them were much too far inclined inwards; her mother was much distressed on account of the deformity, but thought it useless to attempt to alter it. I assured her it

would not be difficult at her age; she consulted some of her friends for advice on the subject, many of whom, without the slightest reason, discouraged her, but the girl was very anxious to have her teeth made straight, and her mother at length consented to have it tried. As she was going to school at the time, and the band would prevent her from saying her lessons, or of reading so as to be understood, I tried simply the ligatures, by passing under one tooth and over the other, and gave her a stick to press out the teeth, which were inclined inwards, altering the silk so as to force the teeth in their proper places, and in very little over two weeks her teeth were brought perfectly straight, without making use of the gold band at all. Her teeth have continued perfectly in the proper line, and the cuspidati which have since made their appearance make the arch complete.

OF IRREGULARITY IN THE FORMATION OF THE TEETH.

354. This kind of irregularity consists in a deformity of one or more teeth, or of the fusion of two teeth into one, giving rise to *twin teeth.*

OF DEFORMED TEETH.

355. Teeth may be the subjects of deformity, either in their crowns or fangs. The most common deviation in the crown from a perfectly natural state, is a preponderance in size over the opposite tooth in the same jaw. This is so frequent that we can never tell by seeing a molar for instance, on one side, what the size of the same tooth on the opposite side is to be. It is a deformity which rarely goes far, or is productive of any injury. Another deformity of the crown is the growth, generally upon its side, of a little knob or projection; an instance of this is given at Plate IX. figure 1. A very curious deformity of the crown of an incisor is shown on the same plate, figure 2, and a still more irregular one at figure 3.

356. The fangs are often deformed, being bent in every direction, sometimes like the letter S, and occasionally almost like a bayonet. Some of these deformed fangs are seen in Plate X. figures 16, 17 and 18. Supernumerary fangs sometimes exist, and those of two contiguous molars are interlocked in such a manner that it would be impossible to extract one without the other. Several very curious forms of deformed fang are portrayed in Plate IX. figures 10, 11, 12, 13, 15, 16, 17 and 18, also in Plate VI. figures 43 to 49 inclusive.

CAUSES OF THIS FORM OF IRREGULARITY.

357. Deformity, particularly of the fang, usually arises from some obstacle to the growth of the tooth, most commonly from the presence of the temporary tooth. Some of the deformities, however, cannot arise from this cause, but must depend upon some irregularity occurring in the formative or saccular stage, or an error in the germ of the tooth itself.

358. *Treatment.*—But few of these cases can properly be said to be amenable to treatment, although in case of a bulb on the crown becoming a source of inconvenience, it may be removed by the file, taking care to polish the surface well, which is left after its removal.

TWIN TEETH.

359. The occurrence of twin teeth, or teeth united to each other inseparably by their ivory, has been doubted by writers; but the cases have multiplied to such an extent that a doubt of the true and perfect union of two or more contiguous teeth cannot obtain at the present day.

360. The cause of the union exists in the germs themselves, and we may look for it as far back as the papillary stage of the tooth. It is most probable that two germs cohere in the primitive dental groove, and come to be enclosed in the same membrane, so that they are perfected and rise together.

361. There is a condition liable to be mistaken for this, consisting in an union of the fang of two contiguous teeth to the intervening plate of alveolus, arising from the ossification of the periosteum. This can readily be distinguished, for in a true case of twin teeth the ivories unite, and the enamel is continuous from one to the other. Sometimes a depression in the enamel shows where the teeth are joined, while at others it forms a continuous surface.

362. Twin teeth are shown in Plate IX. figure 9, it being thought unnecessary to multiply examples. The occurrence of this union is much more frequent in the temporary than in the permanent set.

363. Cases of this kind of irregularity do not seem to have been very numerous. Mr. Fox gives four cases, the specimens still existing in the Museum of Guy's Hospital. Mr. Bell relates four cases. Harris, in his Dental Art, states, that he saw two cases which appear to have occurred in the permanent set. He also mentions one as having been

seen by J. D. M'Cabe. Three specimens exist in the Wistar Museum, and Mr. Parker has met with two cases and possesses the specimens. These latter cases occurred in the temporary teeth. Many other cases might be found on inquiry, but enough has been said to prove that the irregularity is not very rare.

OF IRREGULARITY OF NUMBER.

364. This may be produced by either a deficiency or a redundancy of the usual number of the teeth. The deficiency usually occurs in the *dentes sapientiæ*, an occurrence which is more common in *women* than *men*. This deficiency is doubtless only apparent in some cases, the last molar being developed in the ramus of the jaw. When it really does occur, it arises from some deficiency in the cavity of reserve, in which it is usual for the *dens sapientiæ* to be developed. A redundancy constituted by one or more supernumerary teeth, is stated by Maury to be more rare, though it has been more frequently referred to by writers than deficiency.

365. When supernumerary teeth occur it is generally in the permanent set, and most probably owe their origin to the development of extra papillæ, at the time of the formation of the secondary dental groove. They are monstrosities produced by the same law which causes the production of additional fingers and toes.

366. They are rarely so perfectly formed that they can be arranged with any class, though examples to the contrary have occurred. Bell, Harris and others have mentioned cases in which the supernumerary teeth were not only well shaped, but well arranged in their alveoli, and the negro mentioned in Paragraph 358, has to all appearance a perfect mouth, the new members being well arranged in the dental arches, and except that his mouth and teeth are enormously large, a casual observer would not notice the fact.

367. The classes of teeth in which supernumeraries are usually arranged, are incisors, bicuspid and imperfect molars. When taking the place of the incisors, they are generally pointed and conical in their crowns, and rugose and contorted in their fangs. An example of a supernumerary occurring between the central incisors, will be found in Plate X. figure 21, and another between the lateral incisors and cuspid on the same plate, figure 25. Single teeth, one an incisor and the other a bicuspid, are shown in figures 10 and 15. A very interesting example from Fox, is given in Plate X. figure 23, in which two supernumeraries made their appearance behind the central incisors of the upper jaw, and occupied so much space that they produced great irregularity, and the appearance of a double row.

368. A drawing of a very interesting specimen in the Wistar Museum, may be found in Plate XI. figure 13, in which a supernumerary has made an active effort to rise between the last bicuspid and first molar, but has been defeated for want of room. This specimen

explains clearly the reason of the wrinkled and contorted appearance presented by the roots of these teeth.

369. As the presence of these teeth almost always occasions irregularity of position, they should be removed, unless one of their neighbours manifests symptoms of decay, in which case it should be removed in preference; for although these teeth are so often deformed, they are generally harder and less liable to decay than the regular teeth. It would not be too much to suppose, that the third set, when it does occur, is composed entirely of supernumeraries, which have been detained in the jaw until a late period of life.

PART FIFTH.

DENTAL HYGIÈNE.

CHAPTER FIRST.

OF THE MEANS OF PRESERVING THE TEETH.

370. After what has been said of the structure of the teeth, and the cause and means of preventing decay, it seems superfluous to say that the best and only mode of *preserving* the teeth, is to keep them *perfectly* clean; and this portion of the work will be devoted to giving the best method of obtaining this desirable end.

371. To keep the teeth perfectly clean is a very difficult matter, for the mouth is filled from time to time with matter which is either soft and pultaceous, or rapidly made so by the act of mastication. Besides this the salivary glands are unceasingly pouring out their secretion, from which is deposited the substance which is ultimately to be converted into tartar.

372. A very important means of removing these deposits, almost as fast as they form, is the use of the toothpick. This instrument is made of a variety of substances, of which the worst are some of the metals, and although a gold or silver toothpick may look very well in the hands of an exquisite, it should be kept out of the mouth of a sensible man. A common quill furnishes us with a substance which from its softness, toughness, elasticity and durability, leaves nothing to desire.

373. Although it is considered ungenteel by many to use the toothpick, it should nevertheless be applied *frequently* during the day, and *always* after eating, by every one who desires to preserve the health and beauty of their teeth. When the teeth are very near together, the quill is too thick to pass between them; in such cases a piece of floss-silk or a thin strip of gum-elastic should be passed between them, so as to remove the deposit from the food, which is a most prolific source of decay. This is a point too much neglected, and its neglect gives rise to the opinion that the teeth decay from pressure on each other, whereas, it really takes place in consequence of the difficulty of keeping so narrow a fissure clean. Besides this constant use of the toothpick, the whole set must be thoroughly cleaned once in the twenty-four hours at least, and persons who possess a fine set of teeth, will never find the time misspent, which is occupied in a second cleaning within the period mentioned.

SECTION FIRST.

OF THE MODE OF CLEANING THE TEETH.

374. The instruments for the performance of this essential duty consist of brushes of various shapes and degrees of hardness. They are made of bristles, and we can find at present two kinds. In one the bristles are secured by fine brass wire, which is very liable to corrode and allow the bristles to come out in the mouth. The other variety has its bristles secured by a pin of bone or ivory, which traverses each bundle, and being of the same material as the handle into which they are set, they are not liable to alter, and will last a long time.

375. Some persons make use of a sponge sewed to a handle like a toothbrush handle; but although this is soft and not liable to irritate the gums, it is evident that it is only calculated to clean the most convex and prominent portions of the teeth where there is no danger, and leave untouched the interstices between them, in which the destructive agent lurks concealed.

376. The brush, therefore, is the only appropriate weapon with which to wage war upon this secret and concealed enemy, and this requires some care in its selection. It should be chosen moderately soft, and as *elastic* as possible. When they are made of the bristles in their natural state, they possess this property in the highest degree, though they do not look quite so well as when they are prepared, but the preparation or bleaching always diminishes or destroys the elasticity.

377. If too hard a brush is used, it irritates the gum, and sometimes, particularly if some of the gritty dentifrices are employed with it, denudes the necks of the teeth and causes their early loss.

378. If the individual possess a perfect set of teeth, there is no occasion to use any liquid or substance with the brush, except pure water; though harm can never arise from using a small quantity of fine soap, which, although its taste is not always agreeable, effects their cleansing perfectly, and would neutralize any acid which might be present.

SECTION SECOND.

OF THE SUBSTANCES USED IN CLEANING THE TEETH.

379. A reference to the chapter on caries will explain why alkalies or alkaline substances almost always enter into the formation of dentifrices; and they must be considered when properly used as the most efficient antidotes to decay. Pelletier's Odontine, a new preparation which has the sanction and approbation of the French Academy, is composed chiefly of soda, and the culms or stalks of any of the grains, as wheat, rye, &c. burnt to ashes, form most admirable dentifrices. The ashes of a segar have long enjoyed a popular preference as a dentifrice, which they owe to their alkaline character alone.

380. In composing a dentifrice, two objects are to be attained; namely, the preservation of the teeth from decay, and the removal of foreign substances from their surface. The first of these objects is attained by the means mentioned in the last paragraph, and the other by some gritty or cutting substance, the most common being the solid mass found in the body of the *loligo* or cuttle-fish.

381. Powdered pumice stone is sometimes used, but unless very fine should not be employed, as it will rapidly cut away the enamel.

382. When bitter or astringent substances are added, they are intended to remedy any sponginess or other disease about the gums, but they always act injuriously upon the whiteness of the teeth, as they are constantly accompanied in their natural state with some colouring matter. Whenever, therefore, they are required, it would be much better to substitute their proximate principles, such as tannin and quinine, which being separated from colouring matters, will not sully the purity of the teeth. Myrrh, which is frequently used as a tincture mixed with water, is particularly liable to this objection, as it soon gives the teeth a deep yellow tinge. There is reason to doubt if there can be a better application to the gums than tannin or gallic acid, dissolved in alcohol and flavoured by some essential oil.

383. We have heard much lately of chlorine and creosote tooth-washes. They are generally quack mixtures got up to sell. Creosote is said to hasten the decay of the teeth; *if so* it must be objectionable, and if there is any chlorine in the so-called wash, it is very injurious to gold plugs, in fact I have known one to be rendered spongy and loose in a short time by the use of chloride of lime in solution. Chlorine, it must be recollected, is the proper solvent of gold.

384. I have added in the next section, a few of the best receipts for dentifrices, which I could meet with. They have been used for a long time, and still enjoy a good reputation.

SECTION THIRD.

DENTIFRICES.

385. Dentifrices should be *very* finely pulverized, and then to insure the absence of gritty particles, should be sifted through a sieve made of bolting cloth. To accomplish this well, the ingredients must be thoroughly and perfectly dried over a sand-bath. Any of them may be converted into what is called an opiate, by mixing them with honey to the consistence of a paste.

A SIMPLE AND GOOD DENTIFRICE.

Peruvian bark, (yellow or pale,) three ounces.
Armenian bole, - - one ounce.
Prepared chalk, - - half an ounce.
Oil of bergamot, - - twenty drops.
Mix.

PROFESSOR HUFELAND'S DENTIFRICE.

Peruvian bark, - one ounce.
Red Saunders, - four drachms.
Alum, - - one drachm.
Oil of cedrat., (or lemon,) two drops.
Mix well together.

If desired, the above ingredients may be mixed with honey and used as a paste. Called Hufeland's Paste Dentifrice.

A POLISH DENTIFRICE.

Peruvian bark, -	two ounces.
Florentine iris root, -	one ounce.
Muriate of ammonia,	four ounces.
Catechu, - -	six drachms.
Myrrh, - - -	six drachms.

To these ingredients may be added a few drops of any of the essential oils.

BETTON'S DENTIFRICE.

Cuttle-fish bone, - -	four ounces.
Florentine iris root, - -	four ounces.
Rose pink, - - -	one ounce.
Musk,* - - - -	three grains.
Oil of Rhodium, (or attar of roses,)	ten drops.
Oil of lavender, - - -	ten drops.

AN EXCELLENT DENTIFRICE.

Florentine iris root, -	one ounce.
Prepared chalk, -	one ounce.
Yellow Peruvian bark,	two drachms.
Myrrh, - - -	two drachms.
Rose pink, - -	one ounce.

* As this substance is disagreeable to many persons it may be omitted.

DETERSIVE POWDER, (FROM MAURY.)

Magnesia,	- -	one pound.
Cream of tartar,	- -	one pound.
Sulphate of quinine,	-	five drachms.
Cochineal,	- -	one and a half ounces.
Oil of peppermint,	-	four drachms.
Oil of cinnamon,	-	three drachms.
Oil of orange-flowers,		two drachms.

Powder the cochineal and cream of tartar together, and the magnesia with the oils and quinine, then mix secundum artem.

PART SIXTH.

MECHANICAL DENTISTRY.

MECHANICAL DENTISTRY.

386. This portion of the dental art, relates to the means of supplying the losses of the teeth occasioned by accident or the natural progress of decay. So many improvements have been made in this portion of the art, that it would seem to require a very extended notice. I shall, therefore, give as full and particular directions for the performance of each act in this difficult art, as it is possible to do without becoming too tedious. It is in this portion of the work that I am mainly indebted for information to my friend Mr. Parker, who has had a very large experience in the manufacture of porcelain teeth, and I feel confident has not been excelled, in either this country or in any other, in the combination of beauty with solidity, which his teeth present.

387. As many dentists prefer purchasing their teeth ready made, to the trouble of manufacturing them, it may be observed, that they can purchase any variety of teeth from Samuel W. Stockton, Philadelphia, who devotes himself to manufacturing them. Their quality is excellent, and their appearance very natural. They may be purchased also of Alcock and Ambler in New York. A number of teeth have been imported for sale of superior beauty, made by Ash, of London, but they will not, I am told, bear the heat required to solder them to a plate.

388. As I have had to learn this art for the purpose of teaching it, I shall endeavour to give the most exact directions; but it is impossible for any one to reduce a written art to practice without some failures. The advice, therefore, to learn the art practically, from one who is in the daily habit of performing these operations, must not be neglected; but there are situations in which persons are placed, who cannot obtain this kind of information. It is for their use, therefore, that this portion of the work is principally written.

389. I shall proceed to give an account of the various materials used for the replacement of the human teeth when lost; devoting the principal portions of the work to the making and setting of *porcelain* or *incorruptible teeth*. These teeth have become so general as to excite great competition between manufacturers, and as they are frequently presented for competition, it would be well to know what test they should be subjected to. Apart from their beauty, of which almost any one can judge, their power of sustaining a high heat, and a sudden transition from hot to cold, is the most important. This is readily tested by throwing a strong blow-pipe jet upon them, and then casting them into cold water. Very few teeth can stand this severe test.

CHAPTER FIRST.

ON THE SUBSTANCES EMPLOYED FOR ARTIFICIAL TEETH.

WHITE WAX.

390. It is probable that this substance was amongst the first thought of for supplying the loss of the anterior teeth, as it could be applied by the patients themselves. It is usually applied by modelling the teeth, or rather a block representing the teeth lost, in white wax, under warm water. It is then pressed in between the lateral teeth, so as to look something like the teeth which were lost. Of course, they are of no use to bite with, and as they have but a slight hold, are very readily deranged. The only advantage in the use of this substance is that the patients can make and apply them, whilst it produces positive injury by the pressure it produces upon the two teeth between which it is forced. The following case, furnished me by Mr. Parker, will illustrate this point.

CASE.

391. A young lady having broken off the four superior incisors, could not be prevailed upon to have her mouth properly attended to, but preferred filling up the deficiency with white wax. Getting tired of this she applied to have a partial set made of porcelain; but the cuspidati had been forced so widely apart by the use of the wax, that six teeth of the largest size would not suffice to fill up the interval between them. It was necessary, therefore, to extract both the cuspidati and bicuspidati before a well shaped set could be adapted to her mouth. The four broken fangs were all sound, and might have had teeth pivoted to them without one being extracted, so that she had to submit to the pain of extracting ten fangs before the bad effects of the use of white wax could be remedied.

BONE AND IVORY.

392. Both bone and elephant's ivory have been used for a long time for the manufacture of false teeth. They are better than wax, as they can be carved to resemble the natural teeth; but an insuperable objection exists to their use, in consequence of their porous nature. The first effect of this porosity is to absorb the fluids of the mouth and become yellow; this yellowness increases, and is accompanied with a horrible fœtor in consequence of the putrefaction of these fluids in the interstices of the teeth. When they once become fœtid it is impossible to sweeten them again, and as this takes place sometimes in twenty-four hours it has caused their total disuse.

HIPPOPOTAMUS TUSK.

393. This tusk is formed of an exceedingly heavy and dense ivory, and is covered on the anterior side by a thick and white enamel, which resembles the human enamel. The tusks are semicircular, convex on the anterior side and concave behind where there is no enamel. They weigh from two and a half to nine pounds. They should be purchased when they first arrive, and should be kept in a moderately damp place, as they are liable to crack if desiccated. Those whose ivory is white and smooth are the best. By taking advantage of the position of the enamel, either single teeth or blocks may be carved out of it, in such a way as to present the enamel in front, and to have the whole anterior surface of the teeth covered by it.

394. It however soon gets blue and ceases to match the other teeth, and although not so retentive of foul tastes and odours as the last mentioned substances, still it is sufficiently so to cause its rejection for this purpose, except in the absence of better means.

395. It also decays rapidly in the mouth. This substance is still much used in Paris, and in Maury's Dental Art will be found minute directions for its proper application. As, however, I consider it inferior to any of the means which remain to be described, I shall not dwell upon it longer.

NATURAL TEETH OF THE SHEEP AND OX.

396. These teeth, from their resemblance to the human teeth, are frequently used; they must be obtained fresh and not suffered to dry; they are fitted by means of the file to the places intended for them. The only objection to their use consists in their weakness and rapid decay.

HUMAN TEETH.

397. Of all the substances used for dental replacement, these are undoubtedly the best, with the exception of porcelain. A great objection exists in their use on the part of most persons, on account of a fear that they may be the vehicle of contagion, and thus communicate disease to the person in whose mouth they are set. It will be seen that the preparation which they undergo must necessarily destroy any thing of this sort. Such fears are therefore groundless; the only objection to their use arising from their losing their colour, and decaying in the mouth. To render this matter certain, however, they may without injury be subjected to the temperature of 212° F., which has been found to destroy all contagion, even that of small-pox. These teeth should be obtained from subjects not younger than eighteen nor older than forty. If they present the slightest imperfection they should be rejected. After being extracted from the mouth of the subject they should have the end of the fang broken off, and then macerated for a week at least. Maceration is accomplished by placing them in clean water, and changing it twice in the twenty-four hours. They then should be perfectly cleaned and placed in dilute alcohol for preservation. The colourless rum of St. Croix has been found the very best liquid for preserving animal matters in their natural state, and I would, therefore, suggest its use for keeping human teeth. If the subject has a good set of teeth, those taken should be bored and strung in the order in which they existed in the mouth, so that they may be readily arranged if a set should be wanted.

398. It is a curious fact, that when these teeth are placed in the human mouth, they decay as readily as the living teeth, and the progress of the caries is just as regular. It pursues the same course, and with the same rapidity, thus furnishing a strong argument in favour of the views of decay taken in this volume.

INCORRUPTIBLE TEETH.

399. The first idea of manufacturing teeth of porcelain, or some equally incorruptible substance is due to M. Duchateau, an apothecary of St. Germaine, in Laye, as early as 1774. He had an ivory set, which gave him great inconvenience, and he applied to the porcelain manufacturers of Guerhard, in Paris. They failed in consequence of not making allowance for the contraction which occurs in porcelain when it is baked. To discover the remedy for this, he applied to the chemists of the day, and finally succeeded in making a porcelain of a grayish colour which shrunk very little. In 1776 he communicated his secret to the French Academy and was in consequence elected a member.

400. M. de Chemant, a distinguished dentist of Paris, improved these teeth and obtained a patent for the exclusive right to make and set them, from Louis XVI. Since that time such great advances have been made in this branch of the art, that its consideration requires a separate chapter. Their advantages, however, may be stated in a few words:—

1. They may be made to imitate any natural teeth, and they never change colour.
2. They may be used for mastication.
3. They never become foul, nor do they absorb and give out fetid odours.
4. They last for a very long time, and if accidentally broken, are easily repaired.

CHAPTER SECOND.

OF THE MANUFACTURE OF PORCELAIN.

401. Porcelain, when examined, is found to consist of two portions; the one central, is tough and more or less opaque, the other superficial, is glazed or polished, brittle and transparent. The central opaque portion is called the *body*, and the superficial glazed portion the *enamel*. The oriental porcelain consists of two substances only, namely, *Kao-lin* and *pe-tun-tse*. *Pe-tun-tse* being feldspar in its recent state, and *Kao-lin* the same substance disintegrated and decomposed by the combined action of air and moisture. There is a third ingredient added at the present day, to wit, *silex*, in various states of purity. The two ingredients used by the Chinese are ground very fine and mixed in certain proportions, and when so prepared they seem to improve by age, so that it has been a custom to prepare a quantity for future generations, the grandson using that which his grandfather had laid up for him, and at the same time preparing and storing up a similar quantity for his posterity. In the succeeding section these ingredients will be described, and the mode of preparing them for use given.

SECTION FIRST.

OF THE MATERIALS USED IN MAKING PORCELAIN.

402. These are Pe-tun-tse, Kaolin, Clay and Silex.

OF PE-TUN-TSE OR FELDSPAR.

403. Few substances in the mineral kingdom are more widely diffused than this. It forms an essential part of most primitive, and many secondary rocks. It is found of

various colours, but the only kind suitable to our purpose is pure white or nearly so, the colour always arising from some foreign substance. Its name is derived from the German, signifying field-spar, from being frequently found loose in the fields.

404. *External Characters.*—Colours, white, yellowish, gray, brown, bluish, red, and green; occurs massive, disseminated, and crystallized; form, an oblique prism, the sides of which are unequal, and vary from four to ten in number; primitive form, the oblique parallelopiped; common forms, a broad six-sided prism, terminated by dihedral summits, the planes of which stand on the narrow faces of the prism; an oblique four-sided prism, flatly bevelled on the extremities; a six-sided prism, terminated by five unequal faces; structure foliated; cleavage in two directions; lustre shining, and often pearly; translucent; the dark varieties nearly opaque; cross fracture conchoidal; fragments rhomboidal; crystals generally indistinct, and closely aggregated, crossing each other, or forming hemitropes; scratches glass.

405. Its *specific gravity* is 2·54.

406. *Chemical Composition.*—This mineral is composed of one atom of silicate of potash, added to one atom of silicate of alumina; or silex sixty-four parts, alumina twenty, and potash fourteen. It may be represented by the chemical symbol ($KO,Al^2O^3,4SiO^3$).

407. *Localities in the United States.*—Ticonderoga, N. Y., very fine and white. Split-Rock on the margin of Lake Champlain; Germantown; near Fairmount; Philadelphia, and Conestoga Creek, in Pennsylvania; near Baltimore, Md.; Haddam, Conn.; near New York; Southampton, Oakham and West Springfield, Mass.; Lyme, Conn. This is the finer kind, common spar being found in various parts of the United States.

408. *Preparation.*—The feldspar is first placed in pieces upon the fire and heated to a red heat and suddenly quenched in water, it is then to be broken into small pieces, and ground as fine as possible in a mortar.

OF KAO-LIN.

409. This substance, called by the Chinese kaolin or China clay, is the result of the decomposition of feldspar from the united action of air and water. Feldspar, as stated in Paragraph 406, is composed of equal atoms of silicate of alumina and silicate of potash; when the decomposition commences, it loses the silicate of potash by degrees, and when complete nothing but silicate of alumina remains. Now, as the term kaolin, is applied before the decomposition is perfected, it results that this substance differs very much in its chemical characters, being, as just stated, sometimes silicate of alumina in a pure state, and sometimes mixed with a variable quantity of silicate of potash. In France, when pure, it is called kaolin; when not so much decomposed, *sable argileux*, and when but little altered from the state of feldspar, *sable cailloteux*. This sable cailloteux is used in some

of the formulæ which follow, but it is called by its proper name *disintegrated feldspar*. This condition of the spar is marked by a loss of its translucency, and a readiness to crumble, which is not perceptible in the uninjured spar.

410. *External Characters.*—Colour, yellowish, or reddish white; occurs massive; composed of small particles slightly coherent; soft; friable between the fingers; unctuous to the touch; adheres slightly to the tongue; absorbs water, and falls to powder; but does not form a ductile paste.

411. Its *specific gravity* varies from 2·20 to 2·40.

412. *Chemical Composition.*—This when fully decomposed may be represented by the symbol (Al^2O^3,SiO^3), or forty-eight parts of silex and fifty-two of alumina. Thus feldspar in decomposing loses two-thirds of its weight. Decomposed pumice stone furnishes a very white kaolin, which has been used with success in the manufacture of porcelain. On account of its variability it has been found that the kaolin of Saxony contains silex fifty-five, alumina twenty-seven, lime two, water fourteen, and oxide of iron five; whilst that from Cornwall contains silex twenty, alumina sixty, water twelve; and that from Vermont, silex fifty-six, alumina forty-three.

413. *Localities in the United States.*—Monkton, Vermont, a large deposit; near Philadelphia; at Fairmount; and on the Columbia Rail-road; near Wilmington, Del.; and at Washington, Connecticut.

414. *Preparation.*—It is prepared by levigating in water. To do this it is necessary to provide two tubs, one of which should have several holes bored in the side at different distances from the bottom, say three, five, and seven inches. These are to be closed by wooden plugs driven into them. This may be called tub No. 2. Take tub No. 1, and having nearly filled it with clean water, put the kaolin into it and stir it well; then suffer it to stand for several seconds, say ten or fifteen. During this time the coarser particles will have fallen to the bottom by their gravity. Now pour off the upper portion of the fluid containing the finer particles in a state of suspension into tub No. 2. Cover it and allow it to stand until the whole of the kaolin has subsided. When this has taken place draw off the supernatant water by means of the holes in the side, withdrawing the plugs for this purpose. After this the mass must be dried in the sun and preserved for use in well-closed vessels. If the dentist desires to avoid the trouble of this and subsequent operations of a similar kind, he can purchase all the materials for porcelain carefully prepared of Abraham Miller, Philadelphia, or Matthew Foster of Trenton, N. J.

OF CLAY.

415. Some very pure and light coloured clay is used for this purpose; and as all kinds of clay will not answer the purpose, a trial must be made of any peculiar kind, to ascer-

tain whether it shrinks too much in the burning or not. Pipe-clay cannot be used on this account. Mr. Parker uses a grayish-white clay from the neighbourhood of Baltimore, which shrinks very little. It is chiefly used in block teeth, as it enables the operator to model and carve them well.

OF SILEX, OR SILICIC ACID.

416. This substance, which is known in mineralogy by the generic name of quartz, is widely diffused. It exists more or less pure in the form of flint, white sand, and granular quartz, and is found in a state of absolute purity in rock-crystal. Quartz, therefore, should always be selected in the crystalline form, as it is the purest and most easy to prepare for use.

417. *External Characters.* The names of the principal varieties of quartz are, *granular quartz*, *smoky quartz*, *fetid quartz*, *yellow quartz*, *brown quartz*, *limpid quartz*, *milky quartz*, *rose quartz*, *ferruginous quartz*, and *violet quartz*, or *amethyst.*

418. If the specimen is granular, that is, composed of fine grains, of a white or grayish-white colour, and massive, that is, not crystallized, it is granular quartz. If the specimen is of a yellow colour, it is yellow quartz, or citrine; if of a rose colour, it is rose quartz, &c.

419. Many of the varieties of quartz are found both massive, (that is, uncrystallized,) and in crystals; but there are several varieties of stones which are composed almost entirely of quartz, or silex, which always occurs massive, being never found in the form of crystals. These varieties are included in the quartz family, because, like quartz, they are composed almost entirely of the earth called *silex.* These varieties also agree, in many of their external characters, with the description of quartz already given. They scratch glass, give fire with steel, and most of them are more or less transparent, though, as already stated they want the vitreous or glassy lustre, which is so distinct in pure quartz.

420. Its specific gravity is 2.63.

421. It is called in the French potteries, *Sable d'aumont.*

422. *Localities* of rock-crystal or pure silex in the United States. Lake George, N. Y.; Frederick Co., Md.; Grafton, Vt.; Newbury, S. C.; Abington and Plainfield, Mass.; Canada Creek, Fairfield, St. Lawrence Co., N. Y.; Chesterfield, Mass.; White Mountains, N. H., and West Hartford, Ct.

423. *Preparation.*—Silex is prepared by heating it red hot and then quenching in cold water. It is then readily pulverized, and should be levigated in the manner described in Paragraph 414. All these substances should be carefully dried and preserved until wanted for use.

SECTION SECOND.

OF THE SUBSTANCES USED TO COLOUR PORCELAIN.

424. These substances are either metals in a state of minute division or metallic oxides. They are used by mixing in certain proportions with either the body or the enamel, or both. The most common mode of applying them to the colouring of teeth, is to mix them with both the enamel and body. The result is not absolutely certain, as the colour is deeper or paler according to the degree of heat employed, and the thickness of the enamel. A plan has been tried which affords a good prospect of success, namely, to colour the teeth and gums in the same manner as flowers, &c., are painted upon porcelain. The process is as follows. The oxides are formed into an enamel by being fused with some flux, of which one of the best is formed in the following way:—

Flint glass,	- -	12 parts.
Red lead,	- -	16 do.
Calcined borax,	-	3 do.
Powdered flint,	-	4 do.

This produces an enamel the colour of which is derived from the metallic oxide. The enamel is to be powdered and mixed with oil of lavender, when it may be painted upon the teeth with a brush. When dry they are placed for the third time into the furnace and the enamel fused. The only objection to this plan is, that the coat is very thin, and apt to lose its colour in the subsequent process of soldering. I would suggest the trial of this mode of applying the colour, but would put it on the body and cover it with an enamel which should be transparent enough to show the colour through it.

425. The following are the substances most usually employed in the colouring of porcelain teeth.

SUBSTANCES USED.	COLOUR GIVEN.
1. Chloro-platinate of ammonia, - - - - - -	Blue.
2. Platina in filings or the spongy state, - - - -	Blue gray.
3. Gold in filings or ground from the leaves, - - -	Rosy red.

4.	Per-oxide of gold, - - - - - - - -	Bright rosy red.
5.	Purple powder of Cassius, - - - - - -	Rosy purple.
6.	Oxide of titanium, - - - - - - -	Bright yellow.
7.	Oxide of uranium, - - - - - - -	Orange yellow.
8.	Oxide of zinc, - - - - - - - -	Yellow.
9.	Oxide of manganese, - - - - - - -	Purple.
10.	Oxide of cobalt, - - - - - - - -	Blue.
11.	Oxide of silver, - - - - - - - -	Lemon yellow.

426. I shall proceed to consider these substances in detail, and give a formula for each which will enable any chemist to prepare them for the use of the dentist.

1. CHLORO-PLATINATE OF AMMONIA.

427. Make some nitro-muriatic acid or *aqua regia*, by adding one part of nitric to two of muriatic or chloro-hydric acid. Put this into a thin glass vessel and place it on a warm sand-bath, then drop into it some platina in scraps, grains or filings, and allow it to remain until it has dissolved as much of the metal as it is capable of doing. Then pour off the solution which contains chloride of platina into a larger vessel, dilute it with water to a certain extent, and precipitate it with a strong solution of muriate of ammonia. Separate the precipitate by means of a filter, wash and dry it for use.

2. PLATINA IN THE METALLIC STATE.

428. This is used either in the form of filings or of spongy platinum. This last is the best, and is prepared by compressing into a ball some of the precipitate obtained by the last process and heating it to redness.

3. GOLD IN THE METALLIC STATE.

429. This is used either in filings, or the fine powder which is precipitated from a solution of chloride of gold by means of proto-sulphate of iron. It may also be made by grinding gold-leaf with honey, and then washing the honey out with water.

4. PEROXIDE OF GOLD.

430. Make a saturated solution of chloride of gold, by digesting gold in nitro-muriatic acid. Dilute the solution and precipitate it with aqua ammonia. In doing this great care must be taken not to add an excess of ammonia, as it would re-dissolve the precipitate and give rise to a violently fulminating compound. The peroxide of gold, when properly prepared, is of a brownish yellow colour, and detonates feebly when heated, losing its oxygen and becoming converted into metallic gold.

5. THE PURPLE POWDER OF CASSIUS.

431. This is a peculiar compound of gold and tin, in which the tin seems to play the part of an acid. Under this view the tin may be called stannic acid, and the purple powder a stannate of gold. It has been found by Berzelius to be constituted as follows:—

Gold, - - -	28·35
Bi-oxide of tin, - -	64·00
Water, - - -	7·65
	100·00

432. In the preparation of this article great care is necessary to obtain always an article of the same quality. The following are the rules adopted by Thénard. Make an *aqua regia* of one part of muriatic or chloro-hydric acid, and two parts of nitric, to dissolve the gold. When it is dissolved, dilute it with water and filter it; then make it very dilute by the addition of a large quantity of water. Make also an *aqua regia* to dissolve the tin, of one part of nitric acid and two parts of pure water, to which is to be added one hundred and thirty grains of muriate of soda or common salt to each pint of the dilute acid. The tin should be very pure, and must be *added to* the acid a small piece at a time; when the first piece is dissolved, add a second, and so on until the acid is saturated. The solution should be of a yellow colour, and the operation carried on very slowly and in a cool place. When it is finished, filter the liquid and dilute it by the addition of about one hundred times its volume of water.

433. Now place the dilute solution of gold in a glass vessel and add the solution of tin

drop by drop, stirring with a glass rod incessantly, until the liquid takes the colour of port-wine. Suffer it to stand, and large flocks of the purple will fall to the bottom of the vessel. Decant the solution, wash and dry the precipitate, which will be of the most splendid purple colour.

6. THE OXIDE OF TITANIUM.

434. This oxide, which is also called titanic acid, is found in nature combined sometimes with the oxide of iron, and sometimes nearly pure.

435. *External Characters.*—Colours, red, reddish brown, or copper red, sometimes gray on the surface; occurs crystallized, in four, six, or eight-sided prisms, sometimes terminated by four-sided pyramids, and sometimes with rounded terminations; crystals, often long, straight, acicular, and striated; also occurs in minute, reticulated crystals; and in bent, or geniculated prisms; structure lamellar; lustre adamantine, or metallic; fracture conchoidal, or uneven; translucent; scratches glass; brittle.

436. Its *specific gravity* is 4·24.

437. *Localities in the United States.*—Near Richmond, Va., compact, blood red, in white quartz.—*Bruce.* Also in the counties of Randolph, Amherst, Campbell, and Bedford, Va. At some of these places, fine specimens are found, some of which are near four inches long.—*T. D. Porter.* Near Baltimore, Md. London Grove, Chester county, Penn. Also, in Delaware county, and at East Marlborough. Bergen county, near Schuyler's copper mine, N. J., imbedded in limestone. Its lustre is highly metallic.—*Bruce.* Near New-Haven, and at Oxford, and Litchfield, Conn. At Oxford, it is geniculated, and at Litchfield, it is sometimes reticulated. Worthington, and Leyden, Mass. At Leyden, the crystals are four and eight-sided prisms. Near Kingsbridge, and on Hudson river, N. Y., colour, from dark blood red to light red, sometimes geniculated, and sometimes acicular.—*Bruce.* Windsor, Mass., in great abundance.

7. OXIDE OF URANIUM.

438. This oxide is made use of as it is formed in nature. There are two varieties, the black and the green oxide, the latter of which is found in the United States near Baltimore, Md.

439. Its *Composition* is

Oxide of uranium, - -	72·15
Water, - - - -	15·70
Lime, - - - -	6·87
Oxides of tin and manganese,	1·55
Gangue, - - - -	2·50

440. Its *specific gravity* is 3·10.

It may be pulverized and levigated in water, then dried and preserved for use.

8. OXIDE OF ZINC.

441. This is best prepared by precipitating a solution of sulphate of zinc with carbonate of soda, washing the precipitate, which is a carbonate of zinc, and heating it to redness to drive off the carbonic acid. It is in the form of a white powder.

9. OXIDE OF MANGANESE.

442. This occurs in nature in the form of a coarse black powder, and may be purchased at any chemist's.

443. *Localities in the United States.*—Lawrence county, Arkansas Territory. Near Greenburg, and near Big Sandy River, Ken. Shenandoah county, and Albemarle county, Va. Near Wilkesbarre; also near Lancaster, and in Northumberland county, Penn. Near Hamburg, N. J. Near Troy and near Ancram, and on the island of New York, N. Y. Monkton, Vt., crystallized and earthy. Also at Bennington, from whence large quantities are drawn for use.—*Hall.* Lebanon, Conn. Milton, Lynn, Deerfield, and Leverett, Mass. Also at Dorchester, Adams, Richmond, and Plainfield, Mass.

10. OXIDE OF COBALT.

444. This oxide does not exist in nature.

445. It is made by precipitating a solution of either the nitrate, sulphate or muriate of cobalt, by carbonate of soda, drying it and calcining to a red heat, taking care to exclude

the atmospheric air. It is in the form of a gray powder, and is composed of 100 parts of cobalt and 27·097 of oxygen. Its colouring powers are so great that one part will colour three hundred of borax, almost to a black.

11. OXIDE OF SILVER.

446. This oxide or protoxide is of a deep olive colour. It is prepared by dissolving silver in nitric acid, and precipitating it with potash or soda; then washing it with a large quantity of water and drying it. It consists of 100 parts of silver and 7·6 of oxygen.

SECTION THIRD.

OF MIXING THE BODY AND ENAMEL.

447. The proper proportions of the various ingredients for the body having been *carefully* weighed out, (to do which requires a very good pair of scales, and a set of Troy weights,) they are moistened with water from a dropping bottle,* and thoroughly mixed by means of a pestle and mortar of wedgewood ware. The mass thus obtained, is to be placed upon a slab, which *if possible* should be of porphyry or wedgewood, as glass is so soft that it contaminates the materials. They should then be reduced to an impalpable paste, by means of a wedgewood muller, which may be made from the bottom of a broken wedgewood mortar, and glued to a wooden handle. If the operator has no slab and muller, the materials *may* be ground in a large mortar, but this takes much longer and is never so perfect.

448. When the paste is perfectly ground, it must be suffered to dry to the consistence of a stiff dough, and must then be beaten with a wooden mallet, or thrown repeatedly upon the slab with some force, and for a considerable time. This process renders it solid, and prevents it from shrinking so much in the baking as it otherwise would do.

449. When the paste is fully prepared according to the above directions, it may be kept any length of time without injury, if it is prevented from drying. In fact it mellows or improves when so mixed and kept moist.

* These bottles are made by making a hole through a cork, and introducing a small glass tube or quill through it. The cork is then put into the bottle, which is partly filled with water. When inverted the water will escape in drops, and may be made to flow faster by giving a jerking motion to the bottle.

450. The preparation of the enamel differs but little from that of the body, except that the whole process requires, if possible, more care. Every particle of dust or metallic contamination must be carefully excluded, and a horn, ivory, or whalebone spatula must be used to handle both the body and enamel in the mortar or on the slab. The enamel must be ground as fine as possible, and preserved of a consistence resembling cream.

451. The following recipes for porcelain, are not copied from any work, but are the results of practical experience. The colours will be found to differ from those of most authors, in consequence of the high heat which these recipes require, and which contributes to render these teeth so beautifully translucent, and imitate the natural ones with great accuracy. These recipes, with an inconsiderable exception, are furnished by Mr. Parker, who has practically tested their value.

452. The body of the Sèvres porcelain, whose beauty has rendered it famous all over the world, is composed as follows:—

Kaolin, - - - -	70·
Sable cailloteux, - - -	12·
Sable argileux,* - - -	9·18
Sable d'Aumont,† - - -	5·29
Lime, - - - - -	3·53 (chalk 6·3)

When analyzed it is found to be constituted as follows:—

Silica, - - -	57· to 58·
Alumina, - - -	34·5 to 35·
Lime, - - -	4·5
Potash, - - -	3·

It is glazed with a mixture of feldspar and clay.

453. The following are the recipes alluded to in Paragraph 451.

BODIES FOR BLOCKS.

NO. 1.

Feldspar, - - -	three parts.
Clay (Baltimore), - -	one part.

NO. 2.

Feldspar, - - -	four parts.
Kaolin, - - - -	one part.

* See Paragraph 406. † See Paragraph 421.

NO. 3.

Feldspar, - -	twenty-four parts.
Silex, - - -	twelve parts.
Clay, - - -	six parts.

NO. 4.

Feldspar, - - -	twenty-four parts.
Silex, - - -	twelve parts.
Kaolin, - - -	six parts.

Starch (amidine) may be added to the body for making single teeth, in the proportion of two parts of starch to one hundred parts of dry material; the starch being boiled to jelly before mixing it with the body; but it will not answer to put starch in the body for carving blocks, as it renders them difficult to cut when dry.

BODIES FOR SINGLE TEETH MORE TRANSPARENT.

These can also be used for making blocks, but are much more difficult to carve.

NO. 5.

Feldspar, - - -	eighteen parts.
Disintegrated do., -	six parts.
Kaolin, - - -	two parts.
Flint, - - -	twelve parts.

NO. 6.

Feldspar, - - -	thirty-six parts.
Kaolin, - - -	three parts.
Silex, - - -	two parts.

NO. 7.

Feldspar, -	twenty-four pennyweights.
Silex, - -	twelve pennyweights.
Kaolin, - -	thirty-six grains.

NO. 8.

Feldspar, - -	forty-eight parts.
Silex, - - -	thirty-two parts.
Clay, - - -	three parts.

NO. 9.

Feldspar, - -	sixty parts.
Silex, - - -	thirty-two parts.
Kaolin, - - -	three parts.

NO. 10.

Feldspar, - - -	sixty parts.
Disintegrated feldspar, -	forty parts.
Silex, - - - -	twenty parts.

NO. 11.

Feldspar, - -	seventy-two parts.
Disintegrated feldspar,	forty-eight parts.
Silex, - - -	twenty-four parts.
Kaolin, - -	six parts.

NO. 12.

Feldspar, - -	one hundred parts.
Disintegrated feldspar,	fifty parts.
Silex, - - -	twenty-four parts.
Kaolin, - -	twelve parts.

ENAMELS FOR THE PREVIOUS BODIES.

ENAMEL No. 1.

Disintegrated feldspar,	twenty-four parts.
Flint glass,	twelve parts.
Feldspar,	six parts.

ENAMEL No. 2.

Disintegrated feldspar,	twenty-four parts.
Pulv. blue Canton porcelain,	ten parts.
Flint glass,	three parts.
Borax,	four parts.

This enamel is very fusible, and is used on bodies which are easily fused.

ENAMEL No. 3.

Disintegrated feldspar,	twenty-four parts.
Blue Canton porcelain,	twelve parts.
Flint glass,	six parts.

ENAMEL No. 4.

Disintegrated feldspar,	twenty-four parts.
Flint glass,	twelve parts.
Feldspar,	six parts.

ENAMEL No. 5.

Feldspar,	thirty-six parts.
Disintegrated feldspar,	eighteen parts.
Clay,	twelve parts.

ENAMEL No. 6.

Disintegrated feldspar,	twenty parts.
Flint glass,	one part.

ENAMEL No. 7.

Feldspar, - - -	twelve pennyweights.
Silex, - - -	twelve grains.

The best mode of enamelling, however, is with the frit, which is next given. It gives more trouble, but the beauty of the work repays the artist.

FRIT ENAMEL.

Disintegrated feldspar, -	twenty-eight parts.
Kaolin, - - -	fourteen parts.
Borax, - - -	twelve parts.
Flint glass, - - -	eight parts.
Potash, - - -	three parts.
Nitre, - - - -	three parts.

After fusing the above in crucibles well luted in a furnace for about three hours, and allowing it to cool, the enamel must be removed from the crucibles by breaking them from it; it is then to be finely pulverized, after which add half a part of Canton porcelain and half a part of feldspar. Mix and grind the whole finely together.

GUM ENAMEL.

Gum enamel may be made from any of the recipes given, except those which have clay in them. One grain of peroxide of gold will be sufficient to colour fourteen pennyweights of enamel. If the gold gives too bright a colour, a very small proportion of the oxide of titanium must be added.

COLOURING.

The following are the proportions for colouring both the body and enamel.

GRADES OF COLOUR FOR BODIES.

To Thirty-seven Pennyweights of Dry Body.

The degree of colour is designated by the capital letter, and the colour by the small letter. A standing for the pure uncoloured enamel; B the lightest tint, and F the deepest.

YELLOW.

B. y. Oxide titanium,	2 grains.
C. y. Oxide titanium,	3 grains.
D. y. Oxide titanium,	5 grains.
E. y. Oxide titanium,	6 grains.
F. y. Oxide titanium,	8 grains.

BLUE TINTS.

B. b. Spongy platina,	1½ grains.
C. b. Spongy platina,	2 grains.
D. b. Spongy platina,	2½ grains.
E. b. Spongy platina,	3 grains.
F. b. Spongy platina,	4 grains.

GREENISH TINTS.

B. g. Oxide titanium,	3 grains, and Spongy platina,		1 grain.
C. g. Oxide titanium,	4 grains, and Spongy platina,		1½ grains.
D. g. Oxide titanium,	5 grains, and Spongy platina,		2 grains.
E. g. Oxide titanium,	6 grains, and Spongy platina,		2½ grains.
F. g. Oxide titanium,	7 grains. and Spongy platina,		3 grains.
G. g. Oxide titanium,	8 grains, and Spongy platina,		4 grains.

GRADES OF COLOUR FOR ENAMEL.

To Four and a half Pennyweights of Dry Material.

YELLOW TINTS.

B. y. Oxide titanium,	¼ grain.
C. y. Oxide titanium,	½ grain.
D. y. Oxide titanium,	¾ grain.
E. y. Oxide titanium,	1 grain.

BLUE TINTS.

B. b. Spongy platina,	¼ grain.
C. b. Spongy platina,	½ grain.
D. b. Spongy platina,	¾ grain.
E. b. Spongy platina,	1 grain.

GREENISH TINTS.

B. g. Oxide titanium,	¼ grain, and	Spongy platina,	½ grain.
C. g. Oxide titanium,	½ grain, and	Spongy platina,	¾ grain.
D. g. Oxide titanium,	¾ grain, and	Spongy platina,	¾ grain.
E. g. Oxide titanium,	1 grain, and	Spongy platina,	¾ grain.
F. g. Oxide titanium,	1¼ grains, and	Spongy platina,	1 grain.
H. g. Oxide titanium,	1½ grains, and	Spongy platina,	1¼ grains.
I. g. Oxide titanium,	1¾ grains, and	Spongy platina,	1½ grains.
K. g. Oxide titanium,	1¾ grains, and	Spongy platina,	1¾ grains.

SECTION FOURTH.

OF MOULDING TEETH AND BLOCKS.

454. The moulds for this purpose may be made of plaster of Paris, or some metal such as brass. These latter are more durable, and if properly carved out, produce more uniform and better teeth. The cavities in which the teeth are to be moulded, must be one-fifth larger than the tooth wanted, as the body shrinks in that proportion in baking. If plaster moulds are used they should be prepared with wax to render them durable. To do this, melt some wax, and the mould having been perfectly dried, must be held before the fire until it is hot enough to melt a little bit of wax held against it. When it is ready, paint it with the melted wax in successive coats until it bears out; that is, until the mould refuses to receive any more. Let them cool, and they will be found to have become very hard and tough, and will prove very durable. There is another substance which is even harder than wax, namely, stearine: it is to be applied in the same manner. A series of very excellent brass moulds are represented in Plate XXVI. They are adapted to all the classes of teeth.

455. Having well oiled the moulds with a brush and fine oil, the prepared paste for the body is to be worked or pressed into them. The cavities are not only to be filled, but a redundancy is left projecting, which is to be squeezed out by putting the back of the mould on and squeezing it in a vice.

456. The platina pins having been previously cut from a wire of the proper size, which is very well done with the platina cutter (Plate XXX.), should have one end either flattened with the hammer, or a little head made on them, or better, split at the end by the cutting plyers; they must then be pushed into the holes on the back of the mould, that is, if the teeth are plate teeth. If they are to be pivot teeth they require no pin, but a hole is punched in the soft body by pushing one of the awl-like instruments, represented on the same plate, into the hole made for its reception on the top of the mould. One of these instruments is made like a gouge, and is used first to scoop out a small quantity of the body. The second one is round and smooth, and is pressed into the cavity thus made, making it round and smooth. The teeth are then to be dried, which is done by placing the moulds on a stove, or in a warm place. When they are perfectly dry, the moulds may be separated and the teeth will drop out. If they adhere, a slight tap on the back of the mould with a wooden mallet, will generally detach them. If they are found to have any improper mark derived from the mould, it may be removed by cutting or scraping, and their shape may be slightly altered in the same manner, if desired.

OF CARVING BLOCKS.

457. It is very often better to make a block containing several teeth and their appropriate gums. Having, by the means detailed in Chapter III., obtained a gum-plate, it is to be made the base upon which the block is to be moulded. The body is first rudely modelled in the plastic state, to a proper form, taking care to make every part a little too large. The platina pins are now to be inserted opposite the centre of each tooth, and the model thoroughly dried. When dry it must be carefully carved into a proper shape, imitating the natural teeth as exactly as possible, and making them about one-fifth too large. This requires both skill and care; skill to make the teeth of a proper shape, and care, not to crumble the body by a rude touch, for in this state it is exceedingly frail.

458. A full set of artificial teeth is usually made in three blocks, the front one containing the incisors and cuspidati. This block must be carved and baked first, so that it may shrink as much as it can, the side blocks may then be modelled to it, without leaving an appreciable opening between the front and side blocks when they are all finished.

SECTION FIFTH.

OF BAKING AND ENAMELLING.

459. The teeth being moulded or carved in the manner described in the last section, must now be placed in a crucible having a little dry kaolin at the bottom, and subjected to a bright red heat in a charcoal fire. This degree of heat will not vitrify them, but agglutinates and renders them hard enough to receive the enamel. The body in this state is called *biscuit*, and the process, biscuiting porcelain.

460. When the biscuit is cool, the enamel must be applied to it, a process which requires much care. Having a quantity of the enamel prepared of the consistence of cream, and in several parcels of different tints of colour, it is to be applied to the face of the tooth, previously well cleaned, with a camel's hair pencil, in a regular uniform coat, which should extend beyond the cutting edge of the tooth, so as to give that part of it its appropriate transparency. If the tooth is of a uniform colour, it is only necessary to make it regular and even by means of a needle set into a little handle after it has dried. It most generally happens, however, that the operator wishes to colour the tooth of three different tints, and in the case of blocks, to colour the artificial gums. To do this several parcels of enamel of the proper tints must be mixed, to do which see section third of this chapter, and each put on to its appropriate place. Great care must be taken not to let the rosy gum enamel get on to the teeth, a well shaped edge being formed around each. The tints on the crown of the tooth must be incorporated carefully, so as to blend or shade off into the other enamel, whilst the gum forms a sharp well defined edge. To do this well the coloured enamels should be placed on the tooth and covered by a thin layer of enamel, mixed with an increased quantity of water so as to render it fluid.

461. It is usual to colour the part of the crown next to the neck of the tooth of a yellow, and the tip of a blue. If the predominate colour of the teeth to be imitated is yellow, the thin coat may be of yellow enamel, and on the contrary, if they are blue, this layer may be put on with the blue enamel.

462. The body of the tooth should always be coloured to harmonize with the enamel, or the effect is not good.

463. When perfectly dry, they are ready to go into the furnace.

464. This furnace is of the kind called a *muffle furnace*, and may be seen in Plate XXVII. with all its accompaniments. One of these is the slide upon which the teeth are now to be placed. This is made of strong fire-proof clay, and is represented on the same plate. The grooves in it are to accommodate the platina pins which project from the

teeth, and to enable them to be laid in such a way that their cutting edges may be free, and not come in contact with any thing capable of altering their shape. Before putting the teeth on the slide, it must be pretty thickly covered with kaolin mixed up with water, or a layer of dry powdered silex to keep the teeth from sticking to it. Perhaps the best, however, is a layer of dry kaolin. When pivot teeth are baked, they should be so placed in one of the grooves on the slide, that their edge may project and not become deformed. For this purpose the grooves should be made transverse, which is usually done on a separate slide. (See Plate XXVII. figure 7.) The collar under figure 1, Plate XXVII. must be fitted with a stovepipe, which is best introduced into a chimney to produce a draught.

FIRING.

465. The fire must be kindled with small pieces of charcoal, as it produces but little ashes. Over this must be placed a quantity of anthracite (of a kind that is hard and produces white ashes), broken into pieces about the size of a walnut. To prevent chilling the muffle, the anthracite must be added in small quantities until the furnace is full. When this is fully kindled, and the charcoal wholly burned away, the furnace is to be filled up until it is two inches deep over the top of the muffle with the anthracite, and the stopper (figure 9) put into the upper opening and well luted. The coal should, before this last filling be well shook down under the muffle, as the greatest heat is required at that point.

466. The teeth having been biscuited, and the enamel put on them, are to be laid as directed upon the slide. The muffle (Plate XXVII. figure 2) being in its place, the slide is to be carefully placed in it, and the door (figure 6) luted into the end of the muffle with fire clay. Care must be taken not to shake or stir the fire after this.

467. The test piece, which consists of a platina wire projecting from the end of a plug made to fit the hole in the cover last mentioned, (figure 6,) is now to have one of the teeth of the same batch attached to the end of it, so as to judge of the progress of the baking, and introduced into its place. The second cover (Plate XXVII. figure 5) is then placed over it and tightly luted. The test piece is shown at Plate XXVII. figure 4, the plug at *a*, and the tooth on the end of the wire at *b*.

468. Some prefer a door with three holes, in each of which a test-piece is introduced. The advantage of this is, that the operator can withdraw one test, and if it indicates an insufficient baking, he can go on, knowing that the remaining tests have not been exposed to the cooling process whilst being examined. This plan is very advantageous to beginners, but after some practice, the state of the baking can be judged of without cooling the test-piece too much. Some use no test-piece, but open the muffle and withdraw the slide partially, when they think that they are sufficiently baked. If they are not finished it is quickly returned and allowed to remain some time longer, when it may be again examined. As soon as the test-piece on examination has indicated that the teeth are sufficiently baked,

which is known by the enamel being perfectly fused and polished over its whole surface; the plug must be removed from the upper door, and the stopper (Plate XXVII. figure 8) put into the lower and luted tight. The furnace must then stand until the combustion has ceased and the whole become cool. By this means the teeth will be very gradually brought down from an intense heat to the ordinary temperature, and the particles or molecules of which they are composed, will have had time to arrange themselves in the most compact and best manner. This is usually termed the *annealing* process, and the teeth are said to be either *well* or *badly annealed.* When they are well annealed they will stand sudden changes of temperature without injury, whereas, on the contrary, if badly annealed they will certainly crack under the blowpipe, and thus be rendered useless.

CHAPTER THIRD.

OF SETTING THE TEETH.

469. Starting with the proposition that the dentist has obtained a supply of artificial teeth, the next point is to adjust them properly in the mouth. This requires more mechanical skill and ingenuity than any other part of the business, for although the most minute directions may be given and followed, and numerous illustrations be appended, cases will be constantly occurring to which none of them will be applicable, and the operator will be thrown upon his own resources, guided only by analogy.

470. One of the greatest difficulties in the insertion of porcelain teeth, arises from the inability to manufacture them, and the necessity of resorting to some large manufacturer. The consequence of this is, that after supplying a few patients, the dentist has remaining on hand a stock of teeth which are not likely to be called for in many years, in consequence of their not being adapted to the usual run of cases. For the purpose of remedying this, we have dwelt upon the art of manufacturing porcelain, so that the operator can supply any deficiency, no matter how unexpected.

471. There are two modes of attaching artificial teeth depending upon the existence or non-existence of a fang in the seat of the deficiency. When there is no fang, the teeth must be attached by ligatures or clasps to the neighbouring teeth, being based upon a plate, called a gum-plate. When, however, the fang exists and is healthy, the artificial teeth are attached by means of a pivot, and the manner of doing this will be described in the succeeding section.

SECTION FIRST.

OF PIVOTING FALSE TEETH.

472. This operation can only be practised when there exists in the seat of the deficiency a fang more or less perfect. When a small portion of the crown exists, and the fang is

healthy and the pulp alive, the circumstances are most favourable to the success of the operation. After the fang has been exposed some time, and the pulp is entirely ulcerated away, periosteal inflammation is very apt to follow.

473. The operation is divided into two stages; first the preparation of the fang, and second the insertion of the tooth.

474. To prepare the fang, it must be cut off close to the edge of the gum, and then shaped with the file. When there is much of the crown left, it must be excised at the neck with the cutting plyers; this exposes the sensitive pulp, which must next be destroyed; this is done by running quickly a little instrument (consisting of two or three filaments of fine wire) promptly to the bottom of the dental cavity, with a quick rotating motion, and as it gives most exquisite pain, the movement must be rapidly and thoroughly executed. As the patient is very apt to catch at the hand of the operator, he must have both of his ready, and when one is pulled away, seize the instrument with the other, and so on alternately until the operation is complete. The stump must next be filed with a round or half round file into an arched shape, corresponding to the edge of the gum, and the cavity drilled to receive the plug, by means of one of the drills on Plate XXII. The distance to which it must be drilled varies with the fang, but need never exceed three-eighths of an inch. The tooth is then to be inserted at once, although it is contrary to the advice given by many writers; because it has been found that in the case supposed, namely, where the pulp has to be destroyed, there is much less chance of inflammation if the cavity is promptly plugged up, than if it is left exposed for a short time. Dr. Fitch has recommended plugging the cavity with lead for a few days. To this there is the objection that the patient generally is very impatient for the tooth, and if it is plugged at once, where is the difference between a leaden plug and one of any other material? The pulp being destroyed, the fang is henceforth a foreign substance, and the pivot cannot come in contact with any part liable to inflammation. If, however, it is an old fang, it is very likely that its dental canal is the seat of a purulent discharge, and it is better to leave it partially open for a few days, until this discharge (which is increased by the preparation) diminishes. Having selected the appropriate tooth, it is to be fitted in its place by filing if it is an animal tooth, or grinding on one of the wheels (Plate XXIV.) if it is porcelain. When it is well arranged, it must be fitted with a pivot and pressed up into its place by means of a wooden instrument forked at the end. On no account should it be struck or driven, but if it cannot be pushed into its proper place, it must be taken out and the pivot slightly reduced in size. The pivots are made of various substances, such as gold wrapped with silk, wood, &c. Of these the best is solid, well seasoned hickory, the pivot being cut in the direction of the grain. It must be neatly rounded, and then if there is any fear of a purulent accumulation, it must be grooved or flattened on one side, to form a channel, and thus prevent mischief. When the pivot is first put in, it should fit closely and well, and as it swells when it absorbs the moisture of the mouth, it becomes very firm, and frequently lasts from three to four years.

475. After it is put in, the patient must be directed to close his jaws, and then to execute the usual movements of mastication. If the new tooth is found to interfere with any of these motions, it must be ground until it cannot be touched by the opposite teeth.

SECTION SECOND.

OF THE SURGICAL PREPARATION OF THE MOUTH.

476. This consists in the removal of unnecessary teeth and fangs from the jaws, and the promotion of the absorption of the alveoli.

477. When a tooth is extracted, the first action which ensues is the absorption of the sharp edges of the alveoli, and almost simultaneously the central portion fills up and a sharp ridge is formed in place of the extracted tooth. Over this ridge the gum assumes a cartilaginous hardness, and serves for the mastication of most substances.

478. The object of preparing the mouth is to produce this result, so as to form a firm and healthy bearing for the teeth which are to be inserted.

479. This operation is only necessary when there are no fangs upon which to pivot teeth, and is equally necessary in the case of one tooth as of a whole set. The first thing to be done is to remove all stumps from the mouth, as well as all teeth which are not likely to prove durable. When this is done, the patient should be directed to wait a few days until the soreness has gone off, and then commence to bite upon a piece of soft cork to keep up the rapid absorption of the alveoli, and to harden the gum. This process requires at least six months for its completion, and as patients are generally *impatient*, a temporary set may be made upon a silver plate, gilt by the electrotype process, which may be worn until the changes in the mouth are perfected. Spicula of bone very frequently continue to be exfoliated for several months, giving rise to considerable soreness and irritation. Should this be excessive, they should be removed by cutting down upon and extracting them with a pair of delicate forceps.

SECTION THIRD.

OF THE MANNER OF TAKING AN IMPRESSION AND MAKING A MOULD OF THE JAWS.

480. To prepare a gum-plate for the insertion of one or more teeth, it is necessary to make an exact model of the mouth. For this purpose, the operator having provided some

clean yellow beeswax, immerses it in warm water until it becomes soft enough to model readily. The temperature of the water should be about 100° F. He then takes one of the instruments represented on Plate XXX., of which he should have several sizes, and presses the soft wax upon one or both sides according as he wants a single or double impression, and putting it into the patient's mouth, directs him to bite slowly and steadily upon it until it comes in contact with the whole jaw. If the patient now opens his mouth slowly and carefully, he will leave an exact impression of the jaw or jaws as the case may be. The impression must now be taken out of the mouth, great care being taken not to derange it nor alter its shape. If the first attempt does not yield a perfect impression over the whole, another must be taken until it is complete. The operator next takes a strip of waxed muslin about an inch and a half wide, and wraps it around the wax impression so as to deepen it. It is then to be placed on a table, and calcined plaster of Paris mixed with water to a consistence a little greater than cream is to be poured into it until it is full. Two or three smart blows should then be struck on the table with a hammer, so as to produce a jar and detach any air bubbles that may be hanging about the cast. The plaster must be left until it hardens, and then being carefully detached from the wax impression, it is to be thoroughly dried.

MAKING THE CAST.

481. The plaster copy is now ready for casting from. To do this a box must be provided about four inches square and two deep, without either top or bottom; their places being supplied by two boards of the size of the box. One of these boards is to be laid down on any thing level, and the plaster cast upon the middle of it, the teeth or gums being upwards. Some burnt flour or lamp-black must now be sifted on it until its surface is covered, and over it some fine sand made slightly damp with weak molasses and water. This is to be sifted on until the box is full and pressed down hard. The upper board is now put on and the whole affair inverted. The board which is now uppermost being lifted off, the base of the plaster is brought into view, a sharp awl must be stuck into its centre, and having loosened it with a few light taps, it is to be lifted carefully out, leaving behind it an exact impression in the sand.

482. Sometimes the cast does not deliver readily, being under cut as it were; this can be prevented with a little care, but if it occurs, a little trimming of the sand before it is withdrawn will remedy it.

483. Some brass or zinc, or fusible metal being melted, is now to be poured in until it is full and allowed to remain until cool.

MAKING A BED FOR SWAGING.

484. Having obtained, by the means above detailed, a good cast, the next step is to prepare a bed for swaging or bending the plate into shape. To do this well, provide a ring of iron about three inches in diameter and two high. Set this on some of the casting sand, previously made flat and level, and bank it up on the outside with sand. Now melt a quantity of pure soft lead and pour it into the ring until it is almost full, skimming the surface clean. The casting having been smoked by being held over a candle, or covered with a thin layer of glue and whiting, is then to be placed in it gum downwards and allowed to remain until it is cool, when the cast and its reverse may be separated, by striking them a few light blows with a wooden mallet. The operator now has an exact model of the jaw in zinc, and a reverse in soft lead, which are to be used in striking up the plate, a process described in the next section.

SECTION FOURTH.

OF MAKING AND ADJUSTING GUM PLATES.

485. It is customary in large cities for the dentist to purchase the gold plate ready prepared of the proper thickness; but as it may be sometimes necessary to prepare it on an emergency, I shall next describe the process of making the plate. The first thing is to make the gold of the proper fineness. The fineness of gold is represented by carats. Thus, twenty carat gold is the finest used for this purpose, and about fifteen carat the coarsest. Supposing that the operator has a quantity of gold coin which he is desirous to convert into gold plate fit for his purpose, he commences by making or obtaining what is called the *reducing alloy*.

REDUCING ALLOY.

Silver, - - - -	two parts.
Copper, - - - -	one part.

Fuse them together in a crucible and cast into a bar which is to be preserved for use.

486. As the standard gold is too fine to be used for plates, being too soft and flexible, it is necessary to reduce it by mixing with it a certain proportion of this alloy. The following recipes will be found advantageous.

EIGHTEEN CARAT GOLD.

To make eighteen carat gold from American, British or Portuguese coin, take of

The coin,	- - -	one ounce,
Reducing alloy,	- -	four pennyweights and twelve grains.

Fuse them together.

To make eighteen carat gold from doubloons or other Spanish coin, take of

The coin,	- - -	one ounce,
Reducing alloy,	- -	three pennyweights and sixteen grains.

Fuse.

SEVENTEEN CARAT GOLD.

To make seventeen carat gold from American, British, or Portuguese coin, take of

The coin,	- - -	one ounce,
Reducing alloy,	- -	six pennyweights.

Fuse.

SIXTEEN CARAT GOLD,

Is made by using the following proportions of the same coin.

The coin,	- - -	one ounce,
Reducing alloy,	- -	seven pennyweights and twelve grains.

Fuse.

Or, Spanish coin,	- -	one ounce,
Reducing alloy,	- -	six pennyweights and six grains.

Fuse.

FIFTEEN CARAT GOLD.

American, British, or Portuguese coin, - -	one ounce.
Reducing alloy, - - - - - -	nine pennyweights and eight grains.

Fuse.

Or, Spanish coin, - - -	one ounce.
Reducing alloy, - - -	eight pennyweights.

487. In fusing these alloys, it is necessary to cover the surface with some flux, of which borax is the most commonly used.

488. If, however, the surface of the melted metal is not quite clear, drop a few pieces of sal ammoniac into the crucible, and then use the borax. If the melted gold effervesces or bubbles, add a small piece of nitre or saltpetre.

489. Having obtained a button of melted gold, it is next to be cast into a bar, and forged whilst cold into a plate of the proper thickness. To do this well, the plate must be frequently annealed, that is, heated red-hot and slowly cooled, as the hammer condenses the metal and renders it hard and brittle. Plates are much better made by means of a pair of laminating rollers, but in their absence they may be very well got out by careful forging.

490. The plate provided, the next operation is to cut a portion of it into proper shape. To obtain this, take a piece of tin foil, and laying it on the zinc cast, press it close by means of the leaden reverse. Remove the reverse, and cut the tin foil into the shape of the intended plate by means of a sharp-pointed penknife. This must then be lifted off and flattened and laid on the gold plate, which is then to be marked out by means of it and cut into shape.

491. Care should be taken to arrange the plate so as to receive the clasps for connecting it with the contiguous teeth.

492. In soldering clasps to a plate for a partial set, it is necessary to make them range with the other teeth. To do this well, take the plaster cast of the mouth after the gum-plate is made and fitted to it, and saw off the teeth almost down to the level of the gum with a key-hole saw, and putting the plate in its place, put the clasps around the fac similes of the teeth, which they are to fit, and retain them in place with a little plaster and sand mixed with water. When this dries, solder them while on the cast with the hardest and least fusible solder.

493. The plate is now to be bent with a mallet into a shape approaching that of the cast, and placed in the leaden bed, which must be in its turn placed upon an anvil or some

solid substance. The zinc cast is now put on it and struck with a heavy hammer until the plate takes the exact shape of the gum to which it is to be fitted. The edges are now to be trimmed with a file, and the clasps soldered to the plate, when it is ready for the next operation. The clasps are made of gold, which is alloyed so as to be very elastic and hard; the best substance for this purpose appears to be platina, for if a small quantity of this is mixed with gold and melted, it forms an exceedingly elastic plate. It would be well now to try the plate in the patient's mouth, and see that it fits closely and easily in every part.

SECTION FIFTH.

OF THE MANNER OF ARRANGING PLATES AND ATTACHING THE TEETH TO THEM.

494. This of course varies according to the deficiency to be supplied; when it involves one or more teeth, it requires a different arrangement from that adopted when a full set is demanded. When one or more teeth are to be set, the case is more difficult than when a complete jaw is wanted, and they must be retained in their places by a totally different arrangement. It is considered more difficult to set a single tooth well, than to make a complete set, particularly if the tooth is a front one in the upper jaw. The mode of making the gum-plate for a single tooth, will vary also with the state of the neighbouring teeth; for though it is frequently clasped around the necks of the two neighbours, yet it is infinitely better to pass these teeth entirely, and clasp one of the back teeth. This is recommended on many accounts. It obtains a firm hold by means of a strong and broad clasp on a solid double-fanged tooth, and does not show in the mouth. It is also free from the objection often made to plate teeth, viz. that they wear and loosen the contiguous teeth to which they are fastened.

495. By a reference to Plate XXIX. several plans will be found by which the loss of a single tooth may be supplied.

496. Figure 6 represents a plate with two wire clasps for the contiguous teeth; these clasps are feeble, for a strong one would show too plainly.

497. Figure 7 exhibits a cuspid tooth, which is to be clasped to the first bicuspid alone, this plan answering very well.

498. Figure 8 represents a central incisor, the plate of which is carried back so as to clasp the first molar, being carefully filed out to fit the necks of all the intervening teeth.

499. Figure 9 shows the same tooth, the plate being supplied with two clasps, one for the first molar, and one for the first bicuspid; this renders the attachment very firm.

500. Figure 10 is an artificial second bicuspid, which is clasped around the second molar.

501. A better plan, when it can be adopted, is to gain the support from both sides of the mouth, as in figure 11, where the same incisor, as is shown by 8 and 9, is clasped to the opposite bicuspides. This becomes almost absolutely necessary when several incisors are wanting, as in figure 12.

502. Figure 13 exhibits the plan by which the loss of the two first bicuspidati may be repaired, the clasps being placed on the first molars.

503. Figure 14 is a set consisting of the four incisors and two cuspidati, clasped around the first bicuspid; and

504. Figure 15 includes with these teeth the bicuspidati, making a set of ten which are clasped on the first molares.

505. When the molares of one side are lost, a block should be made of the deficiency and clasped around the last bicuspid, as in figure 16.

506. Sometimes the fangs of one or more teeth are good enough to pivot to, and in this case a combination of the two plans must be adopted, as at figure 17, in which the plate containing the lateral incisors and cuspidati is pivoted to the fangs of these latter teeth.

FULL SETS.

507. When full sets are to be made, great care should be bestowed on the preparation of the mouth, and in taking the wax impression. This being done satisfactorily, there are two modes of attaching the plate to the gums. One by atmospheric pressure, or as it is termed by the dentists, on the suction principle, and the other by means of springs, which are so arranged as to press the gum-plate in contact with the gums during all the movements of mastication.

508. The first plan is to be preferred, but is not applicable in all cases, particularly when the jaws and alveoli are very flat and level. The principle upon which they are attached to the gum is similar to that by which the schoolboy pulls a brick out of the pavement, by means of a circular piece of wet leather, to the centre of which he attaches a string. The success of the measure depends upon the perfection of the fit, which should be so good that nothing but a thin layer of saliva intervenes between the gum-plate and the gum. This plan is particularly applicable to the upper jaw, as the gum-plate may be made to extend over a part of the hard palate, and by enlarging its surface, increase its adhesion to the jaw. Such a plate is shown in Plate XXIX. figure 18, containing a full upper set. With regard to the thickness of the gum-plate, it may here be remarked, that it must be stouter in the case of a full set than in that of a single tooth; also it is required to be

thicker when the alveoli are much absorbed and the gums flat, than in the contrary case. The plate should always, however, be as light as possible, consistent with strength.

509. When the suction principle is not applicable, it is necessary to furnish the plates with springs, which shall cause them to follow the jaw when it is opened. These springs are made of hard drawn gold wire, or better, of a wire made from an alloy of gold and platinum, which is to be coiled around a small wire and attached to the plates in the manner represented in Plate XXIX. figures 19 and 20, the first showing the mode used when the teeth are separate, and the other when blocks are used.

510. Sometimes one jaw only is destitute of teeth; in such a case springs may still be used, one end being attached to the false set, and the other to a gold cap made to cover one of the teeth on the opposite jaw.

511. There are various forms of springs and modes of attaching them, but after all the descriptions which may be given, the dentist must depend upon his own ingenuity, and I shall therefore not dwell upon the subject.

ATTACHING THE TEETH.

512. Having arranged the plate to suit the circumstances of the case, the next part of the process is to attach the teeth to it properly. To do this put some wax on the plate, and having placed the plaster cast of the jaws in the articulator, (an instrument to be described hereafter,) the plate is to be adjusted to its place, and the teeth tried on it. If they do not fit in their places, they must be ground upon one of the wheels (Plate XXIV. figures 7 to 11) until they are exactly adapted. Should an opportunity occur to try them in the mouth of the patient, it should be embraced before the next step of the process.

513. When a full set are getting made, and they are tried in this way, great care must be taken to make the line between the two central incisors coincide exactly with the mesial line of the patient's head and face, or they will not only be set crooked, but they will never be useful for mastication, as the back teeth of one side will come in contact before the other.

514. Having the teeth or blocks set correctly on the plate and held by the wax, a mixture of equal parts of calcined plaster and sand, diluted with water, must be applied to their anterior or convex faces, so as to unite the whole set to the plate; and for this purpose the plaster must extend round the front of the plate to its hollow or gum side. The wax is now to be detached with a penknife, or by immersion in hot water, from the backs of all the teeth and the plate, leaving them held by the plaster and sand in front.

515. The teeth are then to be detached from the plate one by one, leaving the impression in the plaster, and fitted with stays.

516. To do this, cut the stays, the shape and size of which may be seen in several of the figures on Plate XXIX., out of a thicker piece of metal than the gum-plate is made of,

and punch two or three holes in them with the instrument (Plate XXX. figure 2) to suit the platinum pins in the tooth. These holes are to be counter-sunk on one side, and the stays lightly rivetted to the teeth. The stay must then be nicely fitted, by filing, to the plate, and the cast of the tooth in the plaster and sand here comes into play, as it enables the operator to put the tooth in its place, and take it out again, until the stay and tooth fit exactly.

517. The next thing is to solder the stays to the teeth or blocks, and in the latter case it is better to have the stay go the whole length of the block, which is carved to receive it, as in figure 16, Plate XXIX. To do this, the teeth several at a time, are placed on a piece of charcoal hollowed out to receive them, and having wetted the stay with powdered borax and water, and laid a particle of a hard solder upon it, the blow-pipe flame must be thrown upon it, taking care to heat them very gradually, and after the solder runs, to cool them with equal slowness, so that they may not crack in the subsequent soldering to the plate. To solder teeth it is necessary to have a spirit lamp of a form resembling that depicted on Plate XXVIII., and a mouth blow-pipe, or what is better, an eolipile, which is represented on the same plate. When the mouth blow-pipe is used, care must be taken to keep up a constant blast, and to keep the teeth covered with flame. To do this, the operator must breathe through his nose, and by distending his cheeks and causing them to react upon the air thus forced into the mouth, drive it through the blow-pipe. Thus the operator does not blow with his chest, but with his cheeks, and in this way a continued blast may be kept up for half an hour, the individual breathing calmly the whole time.

518. The teeth being soldered to the stays, and carefully cleaned and filed into shape, should now be replaced and bound to the plaster and sand, by means of a very fine annealed iron wire, and are then ready to be soldered to the gum-plate. If the stays do not fit the plate exactly, a little piece of gold foil must be placed under them, so as to leave no perceptible interval. The gum-plate may now be painted with clay and water mixed thin, except where the solder is wanted to adhere behind each stay, which must be left bare and made perfectly clean. Borax and water is now to be applied to each stay, and small pieces of solder laid on the joints. The borax is suffered to dry, and the whole affair carefully placed in the soldering furnace, (Plate XXVIII. figure 3,) which must have some small pieces of charcoal previously placed in it and lighted. The charcoal is now to be piled up over the piece, and the heat slowly raised until the solder fuses, or runs as it is called, which may be seen in the interstices of the charcoal, or by removing a piece or two. This generally occurs over the whole piece at once, but if any part is not quite hot enough, it must be aided by a stream from the blow-pipe lamp.

519. The door of the furnace, which should fit very tightly, must now be closed, and a cover put on to arrest the combustion. The whole must then remain untouched until it is cold. The piece must then be removed, and after taking off the plaster and sand, placed in dilute sulphuric acid and boiled for a few minutes, taking care previously to scrape off the glass of borax. The superfluous solder must then be taken off with cutters and scrapers, and the plate scoured by means of the brush, (Plate XXIV. figure 6,) which is

to be furnished with emery, fine sand, or powdered pumice, for the purpose. It is then washed perfectly clean with strong soap and water, and it only remains to finish the plate with the burnisher, which is to be kept wet with a solution of soap, in which a few drops of prussic acid, or a solution of the cyanide of potassium have been placed.

520. The parts which cannot be reached with the burnisher, are to be finished with rouge and a fine brush, which may be first wet with a mixture of ammonia and alcohol, finishing dry.

521. The rouge is then to be removed with strong soap and water, followed by pure water, and the piece dried by heat.

SECTION SIXTH.

VARIOUS SOLDERS USED IN MECHANICAL DENTISTRY.

522. In making a solder it is necessary to melt in a crucible the least fusible metal first, and to add the others, if there is more than one, in the order of their fusibility. The alloy or solder when made will melt at a lower temperature than any of its constituents. As it is necessary to have solders of different fusibilities, so that the first shall not melt when the second is used, and so on, we have annexed recipes for several, which will be marked in the order of their fusibilities, commencing with the hardest, which is marked A. When the solder is made it must be cast into a mould and rolled or hammered into the form of a riband, from which little pieces may be cut as they are wanted.

GOLD SOLDERS.

NO. 1. A.

SUPER-ROYAL SOLDER.

Fine gold,	- - -	fifteen parts.
Silver,	- - -	seven parts.
Copper,	- - -	four parts.
Brass,	- - -	one part.

Melt together and prepare as directed.

This is chiefly used to solder the clasps to the plate.

NO. 2. B.

Gold,	-	-	-	ten parts.
Silver,	-	-	-	five parts.
Copper,	-	-	-	five parts.

NO. 3. C.

ROYAL SOLDER.

Gold,	-	-	-	two parts.
Silver,	-	-	-	two parts.
Copper,	-	-	-	four parts.

PALLADIUM SOLDERS.

These are used when the gum-plates are made of palladium or platinum.

NO. 1. A.

Palladium,	-	-	-	two parts.
Silver,	-	-	-	one part.

NO. 2. B.

Palladium,	-	-	-	one part.
Silver,	-	-	-	one part.

SILVER SOLDERS.

These are used when a temporary set of teeth are made to supply the patient whilst the mouth gets well settled.

NO. 1. A.

Fine silver,	-	-	-	thirty-four parts.
Copper,	-	-	-	eight parts.
Brass,	-	-	-	three parts.

NO. 2. B.

Silver,	- - -	twenty parts.
Copper,	- - -	eight parts.
Brass,	- - -	one part.

NO. 3. C.

Silver,	- - -	twenty parts.
Brass,	- - -	nine parts.

NO. 4. D.

Silver,	- - -	forty parts.
Copper,	- - -	nine parts.
Brass,	- - -	three parts.

NO. 5. E.

Silver,	- - -	ten parts.
Brass,	- - -	five parts.

NO. 6. F.

Silver,	- - -	forty parts.
Copper,	- - -	nine parts.

NO. 7. G.

Silver,	- - -	forty parts.
Copper,	- - -	nine parts.
Brass,	- - -	six parts.

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EXPLANATION

OF

THE PLATES.

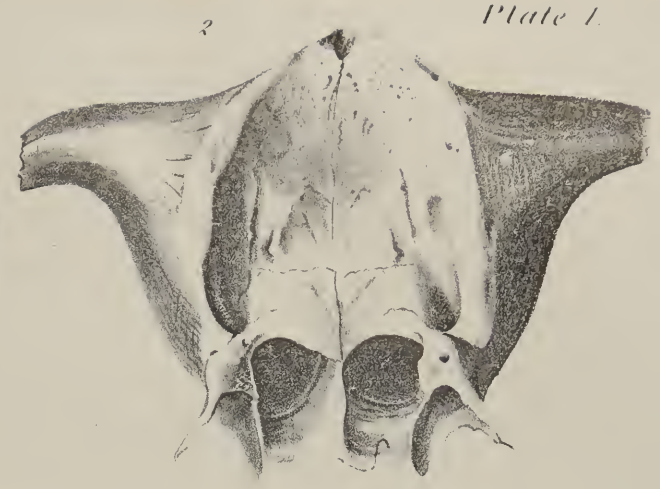
PLATE I.

(*From Nature.*)

ALVEOLI AND JAWS BEFORE THE APPEARANCE AND AFTER THE ABSORPTION OF THE TEETH.

1. Alveoli of adult upper jaw.
    - *a.* Alveoli of three molares.
    - *b.* Alveoli of two bicuspides.
    - *c.* Alveolus of cuspidatus.
    - *d.* Alveoli of two incisores.
2. Upper jaw of aged individual after the loss of the alveoli.
3. Alveoli of adult lower jaw.
    - *a.* Alveoli of three molares.
    - *b.* Alveoli of two bicuspides.
    - *c.* Alveolus of cuspidatus.
    - *d.* Alveoli of two incisores.
4. Aged lower jaw, alveoli absorbed.
5. Head of fœtus before the appearance of the alveoli. Compare it with Plate IV. figures 5 and 6.

Plate I.



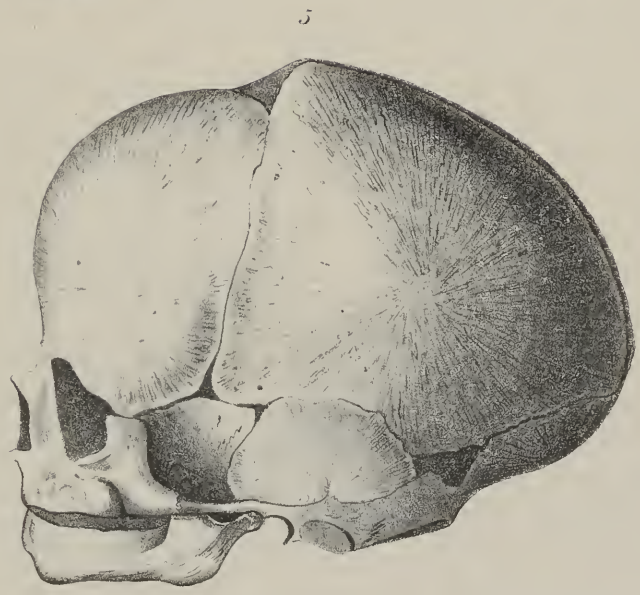


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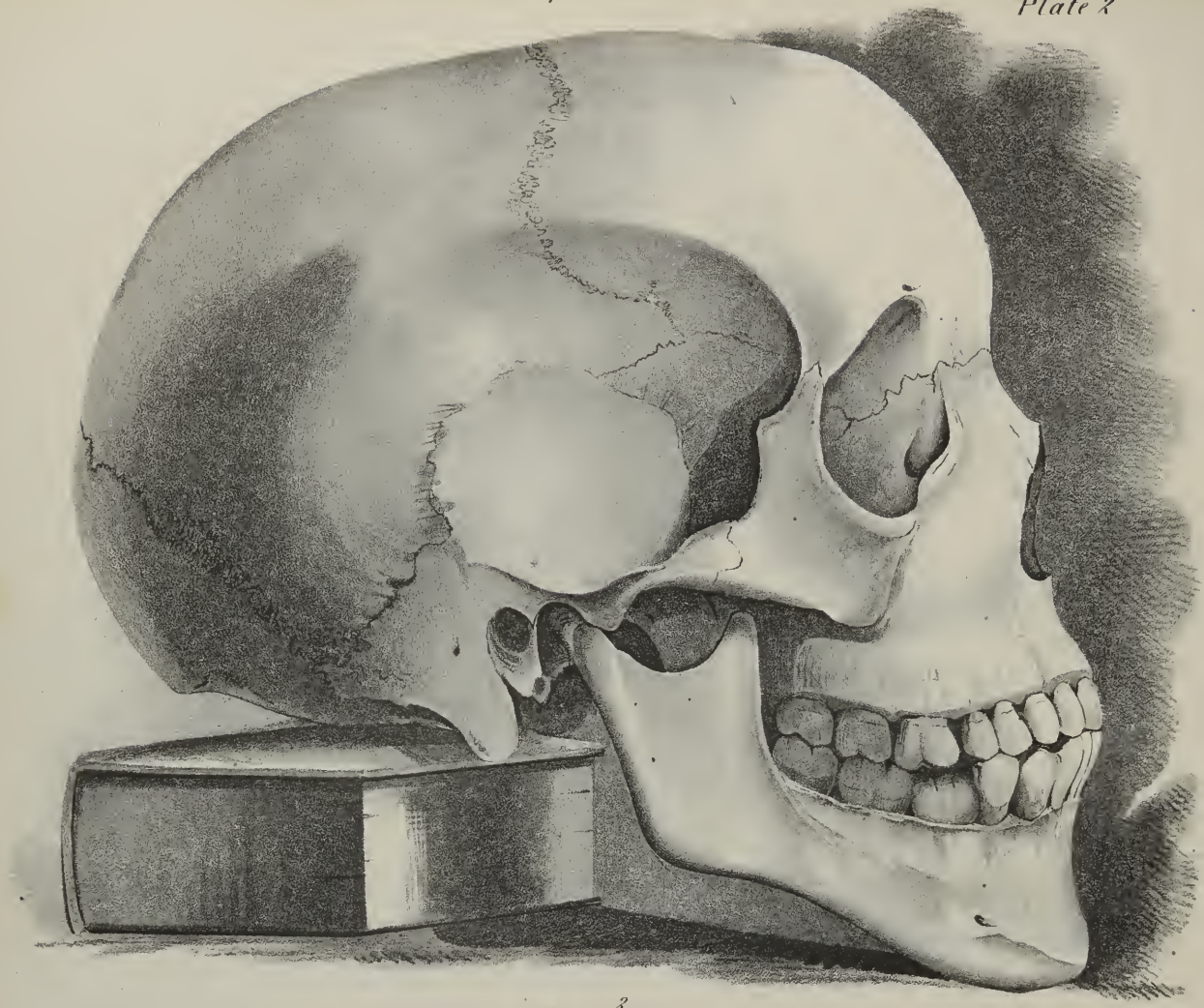
Plate 2



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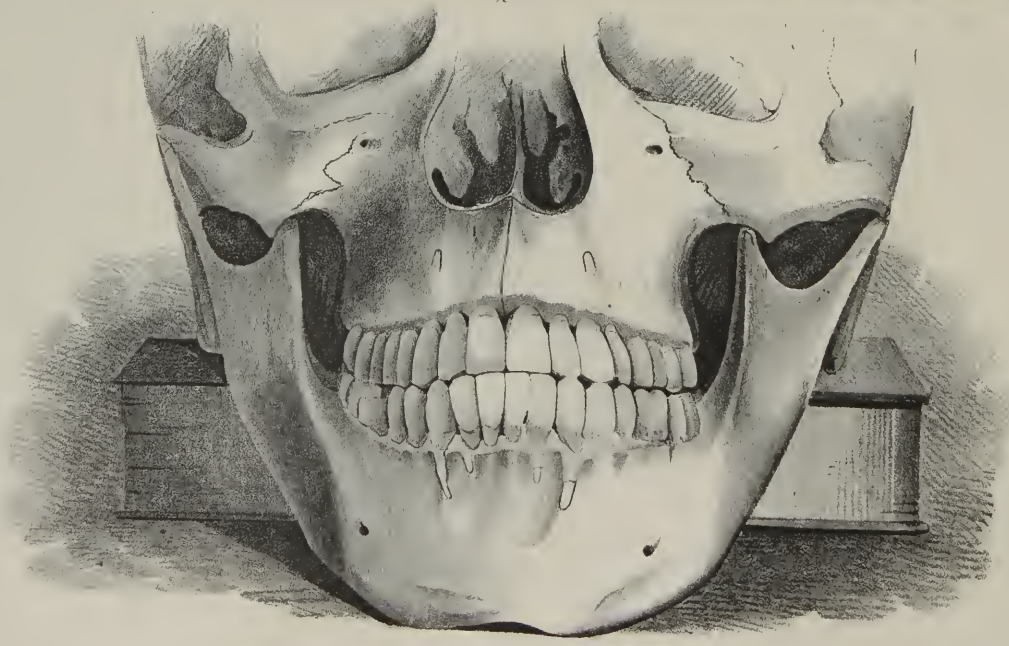

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PLATE II.

(*From Nature.*)

PERMANENT TEETH.

1. Profile of adult head, showing a full set of permanent teeth, thirty-two in all. The curve like the letter S between the two rows of teeth is well exhibited.

2. Front view of the same.

CLASSES OF PERMANENT TEETH.

8	incisores.
4	cuspidati.
8	bicuspidati.
12	molares.
32	

PLATE III.

(*From Nature.*)

TEMPORARY TEETH.

1. Profile of the head of a child at the completion of the first dentition.
2. Front view of the same.

CLASSES OF TEMPORARY TEETH.

8 incisores.
4 cuspidati.
8 molares.

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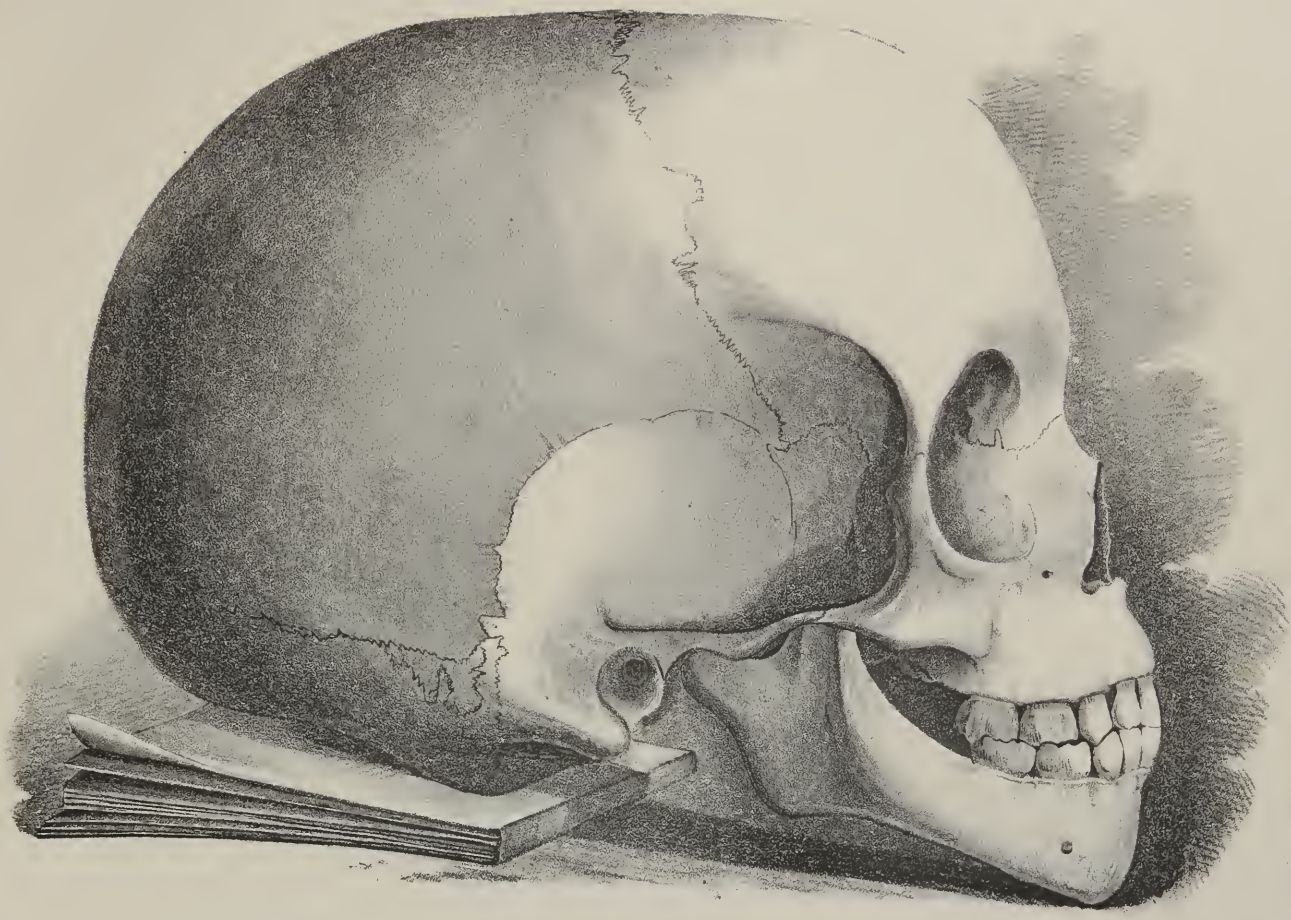

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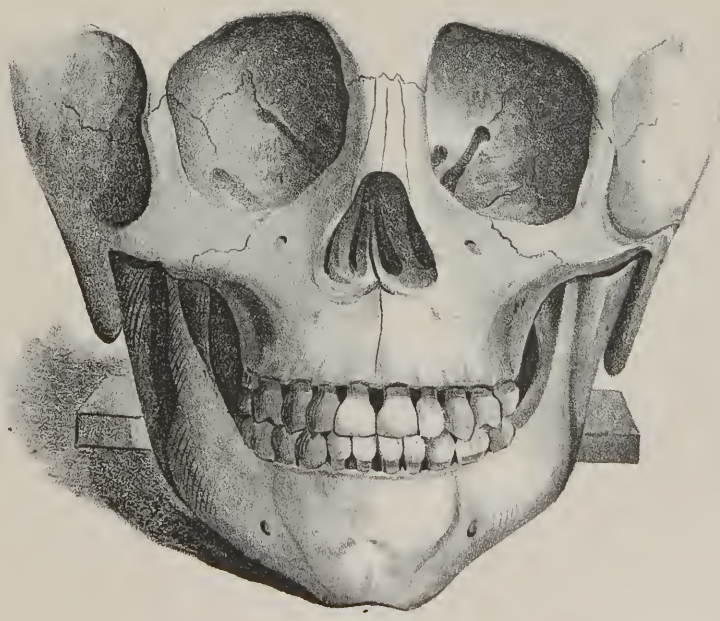

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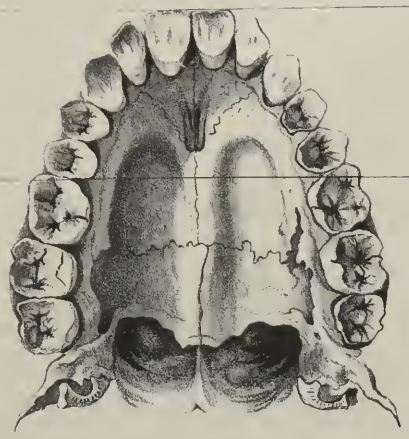

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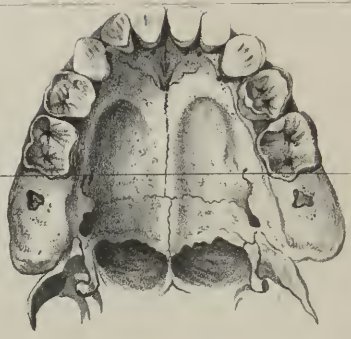

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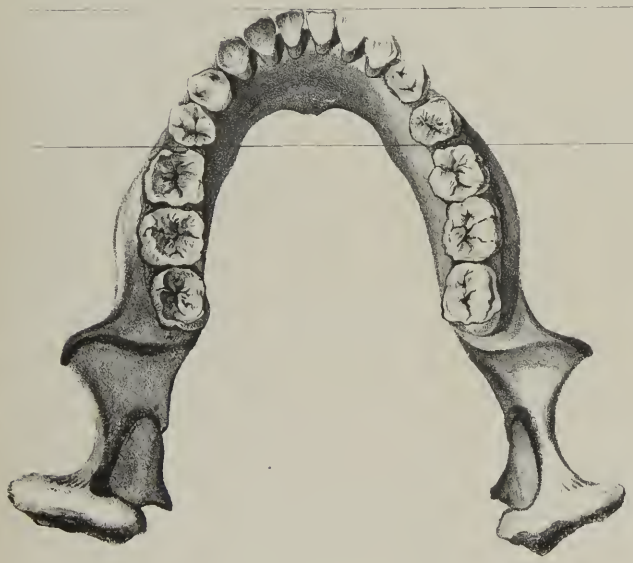

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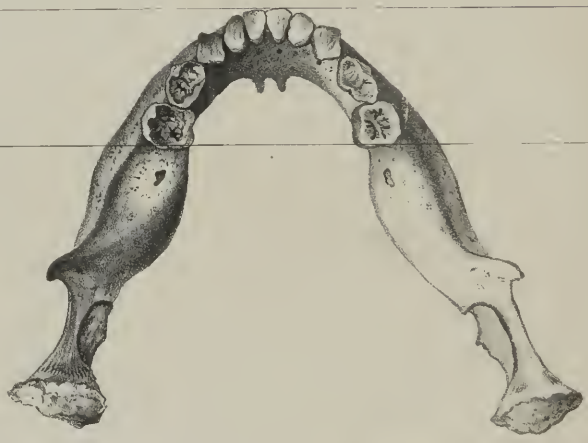

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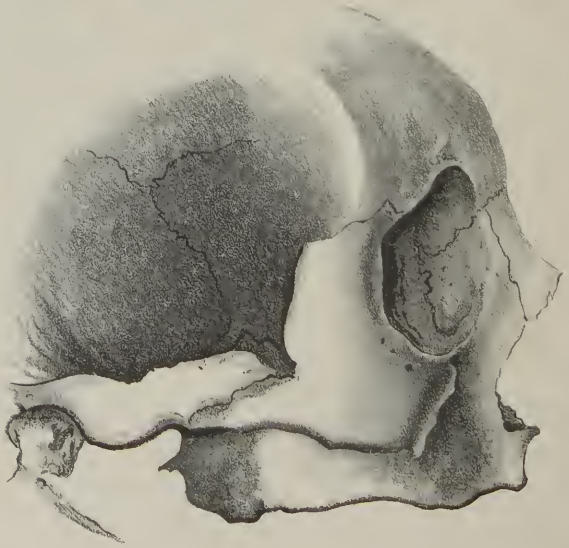

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PLATE IV.

(*From Nature.*)

CROWNS OF BOTH SETS AND EXPANSION OF THE DENTAL ARCHES.

1. Crowns of permanent teeth, upper jaw.
2. Crowns of temporary teeth, upper jaw.
3. Crowns of permanent teeth, lower jaw.
4. Crowns of temporary teeth, lower jaw.

The lines show the expansion of the dental arches, and the manner in which the anterior members of the permanent set take the places of the temporaries.

5. Lower jaw of aged individual seen in profile.
6. Upper jaw of aged individual seen in profile.

PLATE V.

(*From Retzius and Gerber.*)

1. Section of an incisor tooth highly magnified.
   - *a.* The enamel.
   - *b.* The ivory.
   - *c.* The internal cementum.
   - *d.* The external cementum.
   - *e.* The dental pulp.
   - *f. g. h.* The artery, vein and nerve of the pulp.
2. A longitudinal section of the human enamel magnified 350 diameters.
3. A transverse section of the human enamel magnified 350 diameters.
4. A section of cementum magnified 350 diameters.
5. Nerves of the pulp. (Gerber.)
6. Tubuli of the ivory near the dental cavity, magnified 200 diameters.
   - *i.* End next the cavity.
   - *k.* End most distant from it.
7. Tubuli of the ivory under the enamel, magnified 200 diameters.
   - *l.* Ramifications just under the enamel.
8. Transverse and oblique section of the tubuli, magnified 350 diameters.
   - *m.* Oblique section.
   - *n.* Transverse section.
9. Section of tubuli of ivory magnified 400 diameters, showing the granular state of their contents.

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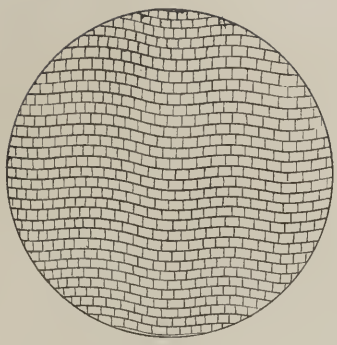

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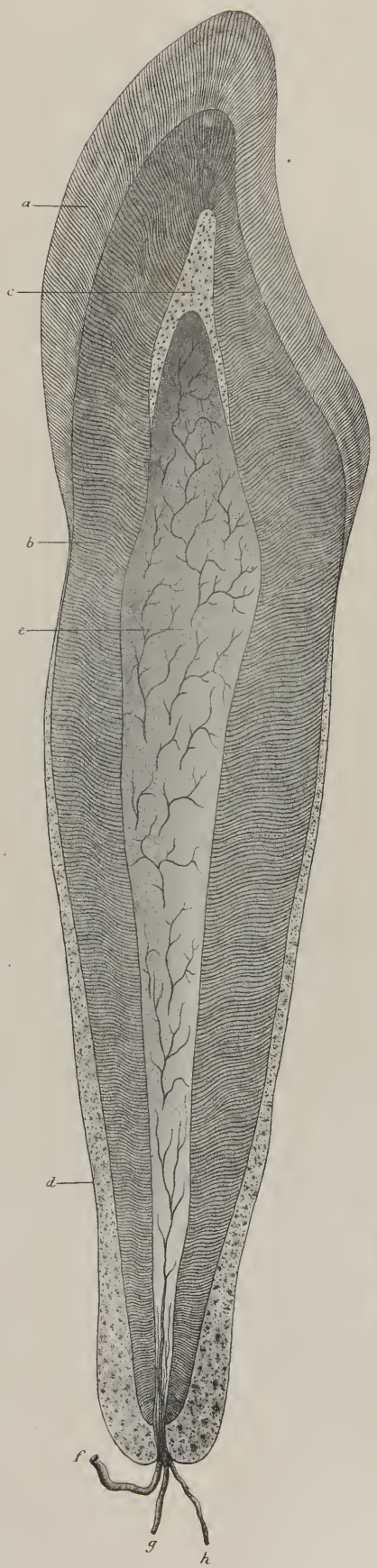

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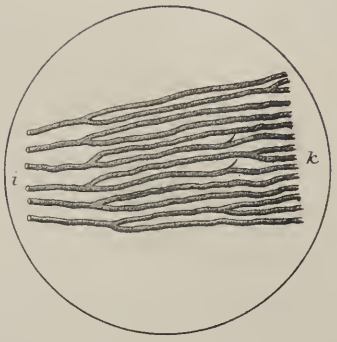

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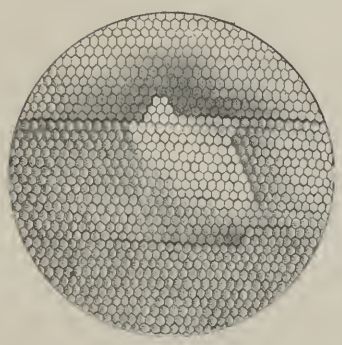

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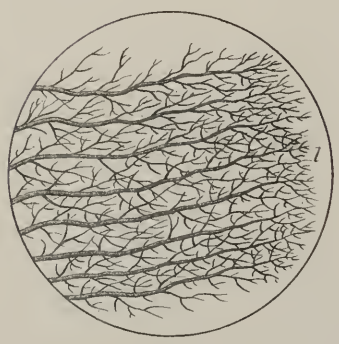

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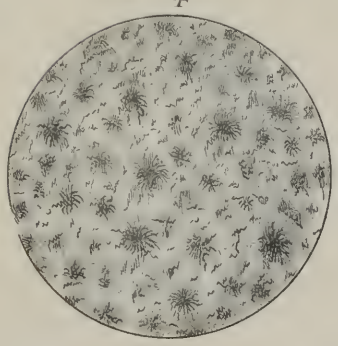

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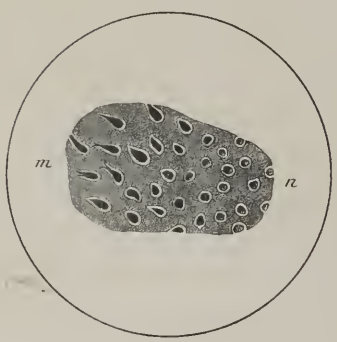

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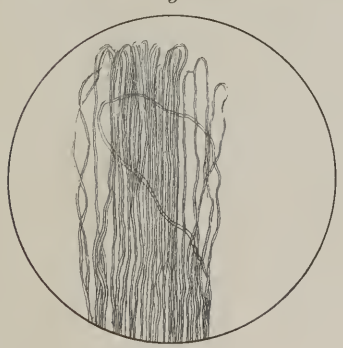

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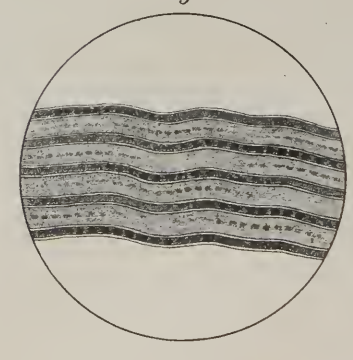

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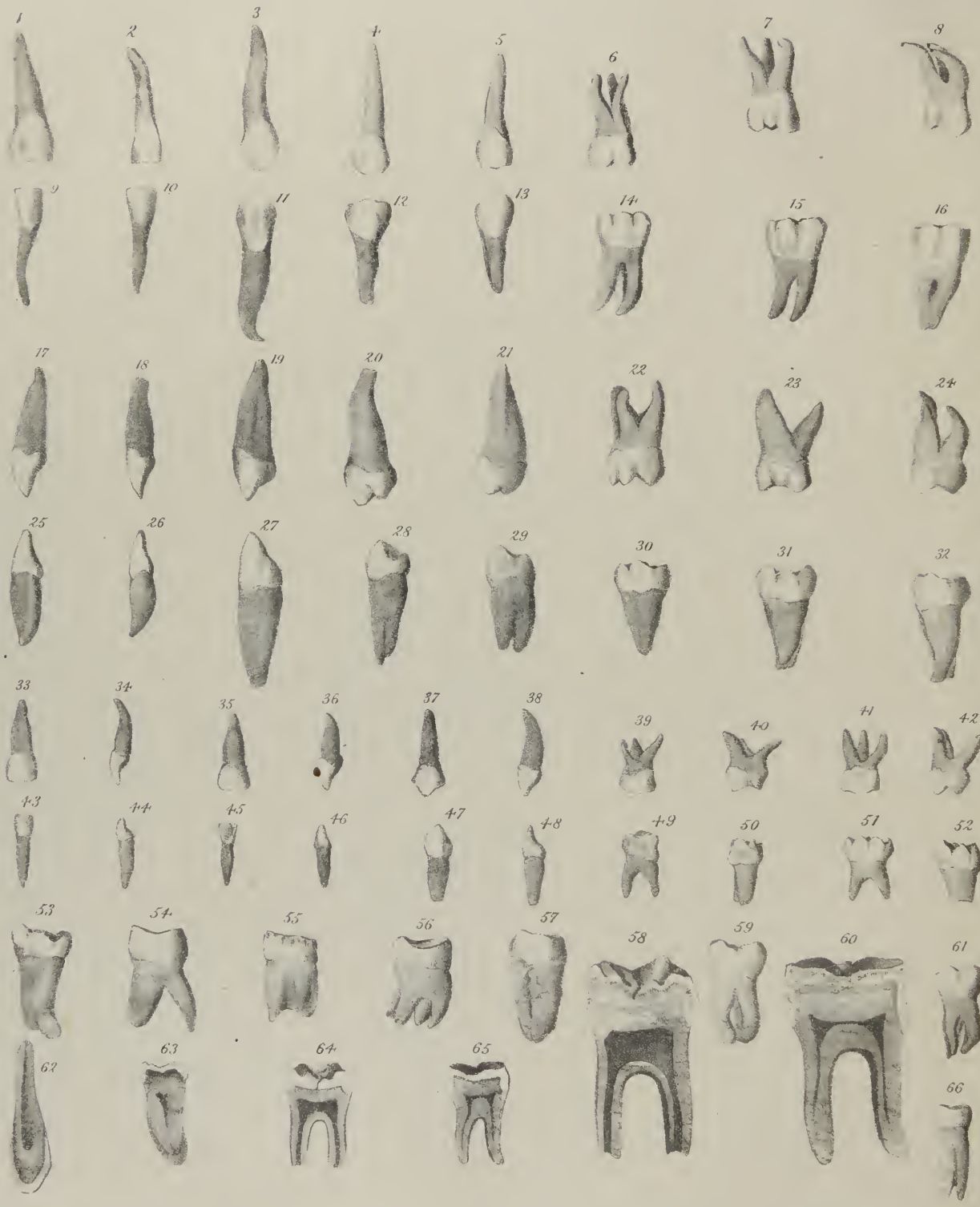

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PLATE VI.

(*From Nature.*)

SEPARATE VIEWS OF PERMANENT AND TEMPORARY TEETH.

1 to 32 inclusive, Permanent Teeth.
33 to 52 inclusive, Temporary Teeth.
53 to 66 inclusive, Varieties and Sections.

PERMANENT TEETH.

1. Central incisor, upper jaw, front view.
2. Lateral incisor, upper jaw, front view.
3. Cuspid, upper jaw, front view.
4. First bicuspid, upper jaw, front view.
5. Second bicuspid, upper jaw, front view.
6. First molar, upper jaw, front view.
7. Second molar, upper jaw, front view.
8. Dens sapientiæ, upper jaw, front view.
9. Central incisor, lower jaw, front view.
10. Lateral incisor, lower jaw, front view.
11. Cuspid, lower jaw, front view.
12. First bicuspid, lower jaw, front view.
13. Second bicuspid, lower jaw, front view.
14. First molar, lower jaw, front view.
15. Second molar, lower jaw, front view.
16. Dens sapientiæ, lower jaw, front view.

17 to 24. Same teeth, upper jaw, side view.

25 to 32. Same teeth, lower jaw, side view.

TEMPORARY TEETH.

33, 34. Central incisor, upper jaw, front and side.

35, 36. Lateral incisor, upper jaw, front and side.

37, 38. Cuspid, upper jaw, front and side.

39, 40. First molar, upper jaw, front and side.

41, 42. Second molar, upper jaw, front side.

43, 44. Central incisor, lower jaw, front and side.

45, 46. Lateral incisor, lower jaw, front and side.

47, 48. Cuspid, lower jaw, front and side.

49, 50. First molar, lower jaw, front and side.

51, 52. Second molar, lower jaw, front and side.

53. Permanent molar, lower jaw, fang distorted.

54. Permanent molar, upper jaw.

55. Dens sapientiæ, lower jaw.

56. Molar, lower jaw, four fangs.

57. Molar, lower jaw, one fang.

58. Magnified section of a molar tooth, showing the cavity in a young individual.

59. Molar, lower jaw, fangs embracing a piece of bone, very difficult to extract.

60. Magnified section of a molar in an individual of forty years of age; dental cavity much diminished by the deposit of cementum, see Plate V.

61. Molar like 59, but of the upper jaw.

62. Section of a cuspidatus.

63. Section of a bicuspid, cementum well seen.

64, 65. Sections of molars, young and old; the same one magnified at 58 and 60.

66. Bicuspid with two fangs.

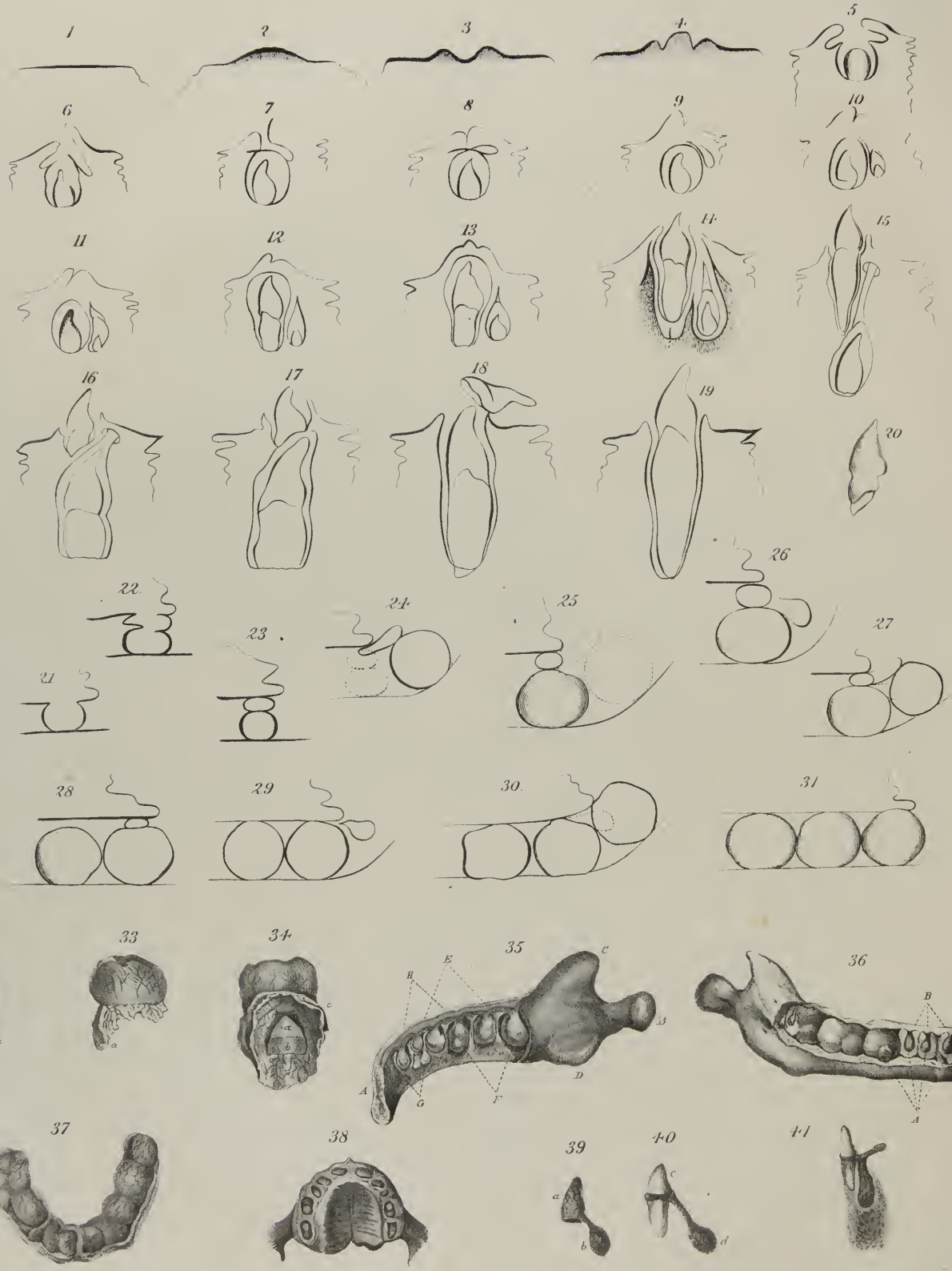

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PLATE VII.

(*From Goodsir, Hunter, Serres, Herissant, and Fox.*)

DEVELOPMENT OF THE TEETH, PULPS AND SACS.

1 to 31. Development from Mr. Goodsir's paper in the Edinburgh Medical and Surgical Journal, January, 1839.

TRANSVERSE SECTIONS.

1. Mucous membrane of gum previous to any change.
2. A granular matter deposited in the mucous membrane.
3. The primitive dental groove in the granular mass.
4. A papilla or tooth germ in the groove.
5. The papilla becoming enclosed; the secondary dental groove forming.
6. The papilla acquiring the shape of a pulp; the opercula forming.
7. The papilla become a pulp, and the follicle a sac, by the adhesion of the opercula.
8. The secondary groove adherent, except behind the inner operculum, where it has left a cavity of reserve for the papilla of the permanent successor.
9. Last change more perfect—enamel organ forming and deposition of bone commencing.
10. The cavity of reserve receding and expanding at the bottom, where a papilla may be seen springing up.
11. The cavity of reserve become a sac with a pulp enclosed.
12. The temporary acquiring a fang and approaching the surface of the gum.
13. Fang longer, sac touching the surface of gum.
14. The temporary sac again a follicle by the eruption of the tooth. Permanent sac getting deeper.
15. Temporary tooth completed. Permanent sac connected with its neck by means of its *gubernaculum* passing through the *iter dentis.*
16. Permanent tooth lengthening—temporary fang being absorbed.
17. Same more advanced.
18. Permanent appearing through the gum. Temporary shedding.
19. Permanent tooth perfected.

20. The shed temporary, with its fang much absorbed.

The previous diagrams explain the eruption and succession of all the teeth, except the permanent molars.

21. Portion of primitive dental groove left free for the first permanent molar.

22. Follicle of first molar.

23. Follicle of first molar become a sac. Cavity of reserve for second formed.

24. Sac of first molar retreating up a curved path into the ramus of the jaw, in consequence of a want of room.

25. Same sac returning, as the jaw grows in length.

26. Cavity of reserve sending backwards the sac of the second molar.

27. Sac of second molar seeking room by retreating into the ramus.

28. Sac of second molar returned as the jaw continues to lengthen.

29. Cavity of reserve forming the sac of the wisdom tooth.

30. Sac of wisdom tooth retreating into the ramus of the jaw.

31. Same sac returned to the dental range.

32. (*Hunter.*) Pulp of a cuspid tooth, with its capsule turned off.

33. (*Hunter.*) Pulp of a molar.

34. (*Hunter.*) Section of a jaw, showing the pulp of a cuspid partly ossified, its membranes being turned off.

35. (*Herissant.*) Dental follicles of the fœtus. F—bottom of the follicles. G—follicles of the permanent teeth.

36. (*Serres.*) A—follicles of the temporaries. B—follicles of the permanents.

37. (*Fox.*) Series of pulps and membranes from the lower jaw of a fœtus of six months.

38. (*Fox.*) Upper jaw of fœtus of six months, the gums dissected off.

39, 40. Mode of connexion between the temporary and permanent teeth (gubernaculum).

41. Section of lower jaw, showing temporary tooth and sac of permanent in the jaw.

Plate 8.

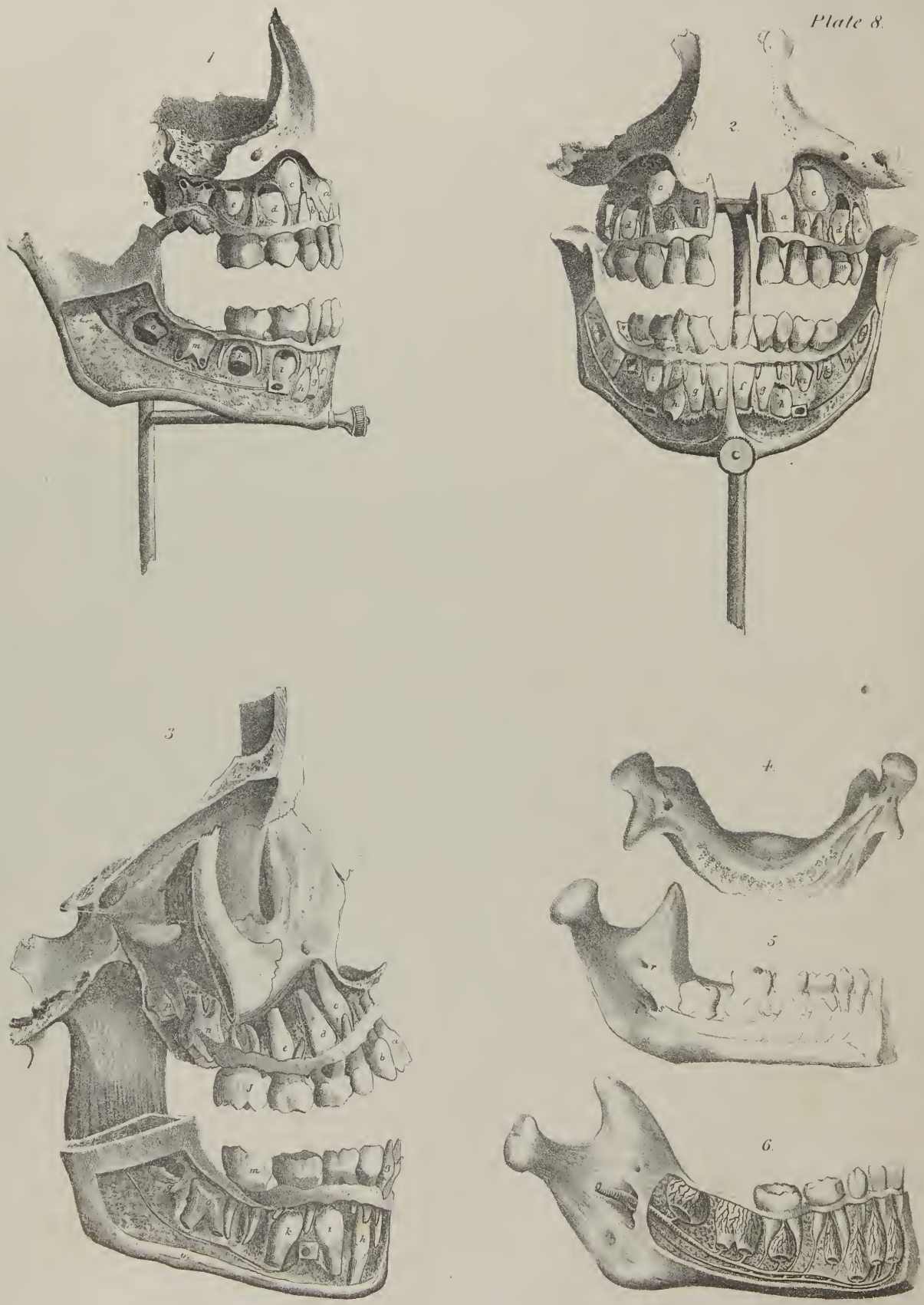

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PLATE VIII.

(*From Nature.*)

SUCCESSION OF THE TEETH.

1. Profile of jaws. Temporary set perfect.
2. Front view of the same.
3. Profile of jaws after the appearance of the first permanent molar and the four incisors.

The letters of these three figures are on the permanent teeth, and are the same in them all.

a. Central incisor, upper jaw.
b. Lateral incisor, upper jaw.
c. Cuspidatus, upper jaw.
d. First bicuspid, upper jaw.
e. Second bicuspid, upper jaw.
f. Central incisor, lower jaw.
g. Lateral incisor, lower jaw.
h. Cuspidatus, lower jaw.
i. First bicuspid, lower jaw.
k. Second bicuspid, lower jaw.
l. First molar, upper jaw.
m. First molar, lower jaw.
n. Second molar, upper jaw.
o. Second molar, lower jaw.
p. Third molar, upper jaw.
q. Third molar, lower jaw.

4. (*Serres.*) The tartar glands of Serres, (mucous follicles.)
5. (*Serres.*) Plan of the three arteries of the lower jaw.

r. Foramen for nutritious artery of the bone.
s. Artery of permanent teeth.
t. Artery of temporary teeth.

6. (*Cloquet.*) The temporary teeth complete. The sacs of the permanent teeth in the jaw. The two arteries, each supplying its own set.

PLATE IX.

(*From Fox.*)

DISEASES AND DEFORMITIES.

1. Tubercle on the enamel.
2, 3. Irregular formation of the crown.
4, 5, 6, 7. Erosion of the enamel, (so called.)
8. Molar, upper jaw, with five fangs.
9. Twin teeth, central incisors united by their ivory.
10, 11. Second and third molars, upper jaw; fangs interlocked; two views.
12. Twin teeth, lower jaw; second bicuspid and first molar united.
13. Lower molar with four fangs.
14. Lower molar with three fangs.
15, 16, 17, 18. Caries in several teeth, accompanied with hypertrophy of the cementum at the end of the fang.
19, 20, 21, 23, 24. A series showing the progress of caries and the course it pursues towards the pulp. (20.)
22. Caries of the centre of the crown of a molar.
25. Sac of an alveolar abscess attached to the end of a fang.
26. 27. Atrophy of the cementum.
28. Effect of absorbent action on a tooth which had been transplanted.
29. Erosion of the enamel caused by sickness in the formative stage.
30, 31. Deposits of salivary calculus or tartar.
32. Erosion of the enamel.

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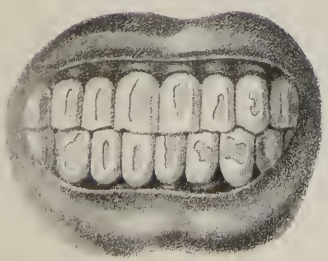

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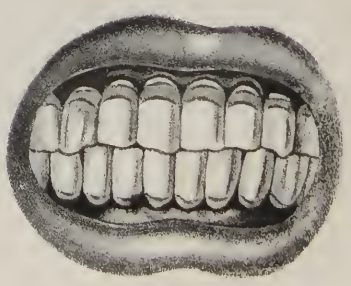

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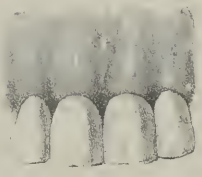

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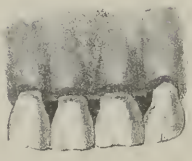

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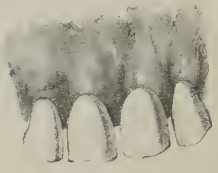

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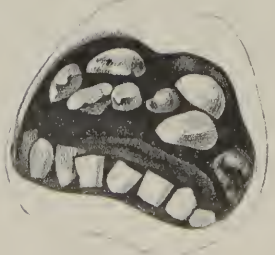

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PLATE X.

(*From Robertson and Fox.*)

DISEASES AND IRREGULARITIES.

1. Crowns of three molars, showing the deficiencies in the enamel, in which decay commences.
2. Ditto, still more marked.
3. Crowns of molars which are perfect and not liable to decay.
4. Crowns of molars worn down by long grinding; points of internal cementum seen.
5. First and second molars, showing spots on the side in which decay commences.
6. Interstices between the teeth which afford a lodgement for foreign substances.
7. Four incisors which will never decay.
8. Four incisors very liable to decay.
9. Teeth wide apart, not subject to decay.
10, 15. Supernumerary teeth.
11. Ridges on the back of the incisors, and spots liable to decay.
12. Deficiencies of the enamel in front of same teeth, affording lodgement for foreign matters.
13, 14. Erosion of the enamel.
16, 17, 18. Deformity of the fang.
19. Mode in which the Malays file their teeth. Dental cavities exposed and decay commencing.
20. Teeth filed to a point by an Abyssinian negro.
21. A supernumerary tooth between the central incisors.
22, 24. Supernumerary bicuspids.
23. Two supernumeraries, giving rise to great irregularity.
25. A supernumerary between the lateral incisor and cuspid tooth.

PLATE XI.

(*From Robertson, Fox, and Nature.*)

IRREGULARITY OF THE TEETH.

1. Obliquity of the incisors.
2. Want of room for the cuspidati, and their projection in front, out of the range.
3. Obliquity of a single incisor.
4. Mode of remedying it with a plate.
5, 6. Plates for this purpose.
7. Irregularity in position of a bicuspid.
8. Irregularity of cuspidati of lower jaw.
9. Obliquity of incisors of lower jaw.
10. Obliquity similar to (3), earlier in life.
11. Bar and ivories described in paragraph 346.
12. False close, lower teeth overlapping the upper.
13. Supernumerary tooth, endeavouring to rise between the last bicuspid and first molar.
14. Second molar developed in the substance of the jaw. These two preparations are in the cabinet of the University of Pennsylvania.

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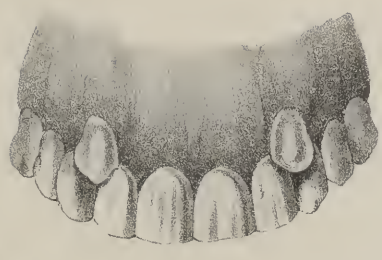

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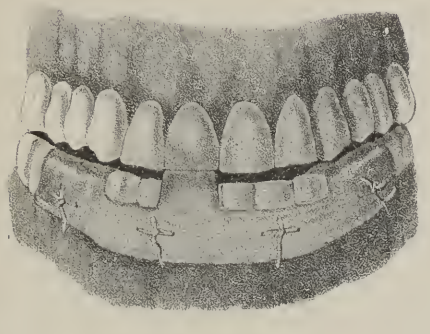

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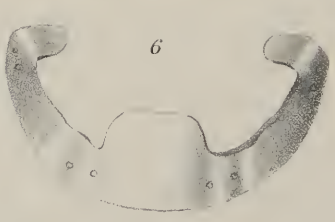

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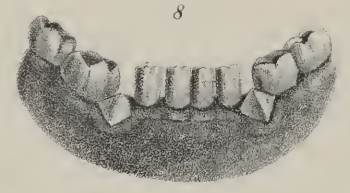

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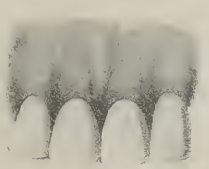

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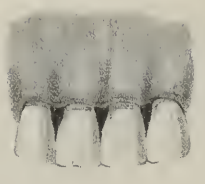

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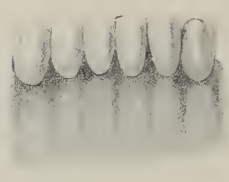

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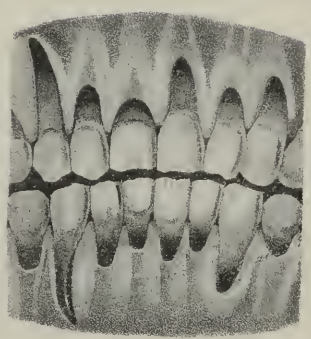

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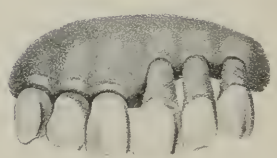

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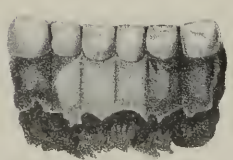

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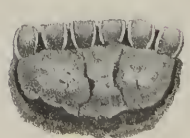

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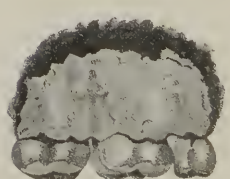

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PLATE XII.

(*From Robertson and Fox.*)

RECESSION OF THE GUMS.—DEPOSIT OF TARTAR.

1, 3. Gums in a healthy state sending pointed processes between the teeth.

2, 4. Gums unhealthy, receding.

5. Gums and alveoli both receding.

6. Denudation of the fangs which are blackened by exposure, produced by the absorption of the gums and the anterior walls of the alveoli.

7. Denudation affecting three teeth only, the opposite ones being healthy.

8. Deposit of tartar coloured by the food.

9. Accumulation of tartar on the front of the incisors, uniting them into a mass.

10. Deposit of white or uncoloured tartar.

11, 12, 13, 14. Deposits of tartar carried to an extreme degree, so as to envelope almost the whole fang.

PLATE XIII.

(*From Quain.*)

THE MUSCLES OF MASTICATION.

Figure 1. The temporalis muscle.

1. 1. 1. Its origin.
2. Its insertion.
3. External lateral ligament.

Figure 2. The pterygoid muscles.

1. 1. Origin of pterygoideus externus.
2. Insertion of same muscle.
3. Insertion of pterygoideus internus.

Figure 3. The pterygoideus internus.

1. Origin of the muscle.
2. Insertion of same.
3. Above the number is a part of the external pterygoid muscle.

Figure 4. The muscles of the face.

1. 1. Origin of the masseter.
2. 2. Insertion of external portion.
3. External lateral ligament.
4. Posterior auris muscle.
5. Superior auris.
6. Anterior auris.
7. Anterior belly of occipito-frontalis.
8. Posterior belly of same muscle.
9. Orbicularis oculi.
10. Compressor naris.
11. Levator labii superioris alæque nasi.
12. Zygomaticus minor.
13. Zygomaticus major.
14. Buccinator.
15. Depressor anguli oris.
16. Orbicularis oris.
17. Depressor labii inferioris.
18. Levator labii inferioris.
19. Levator anguli oris.

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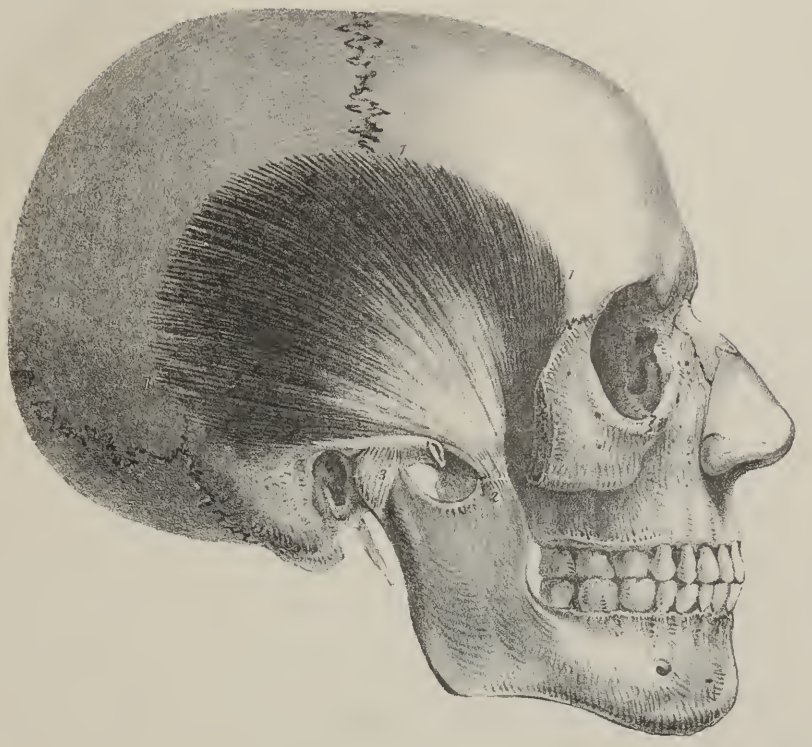

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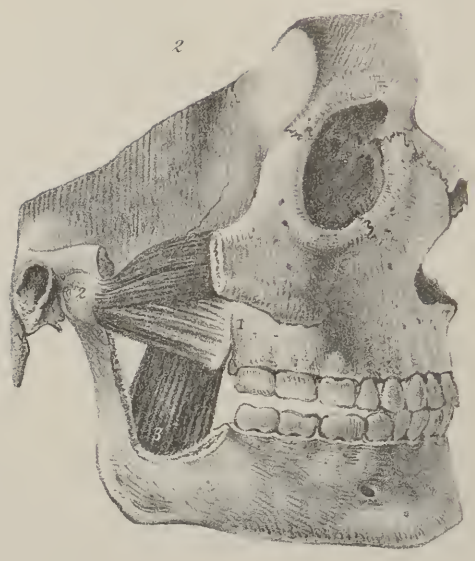

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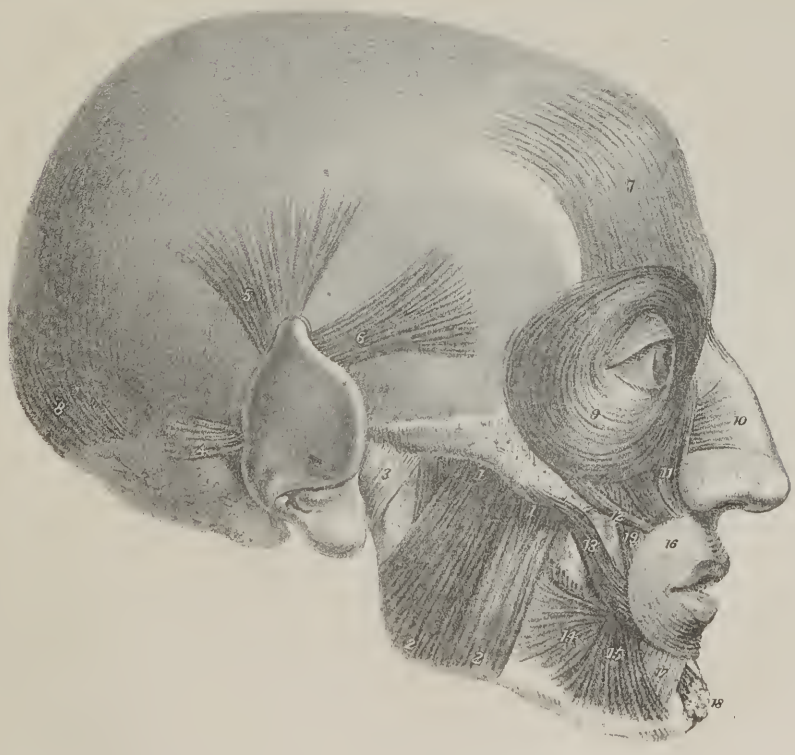

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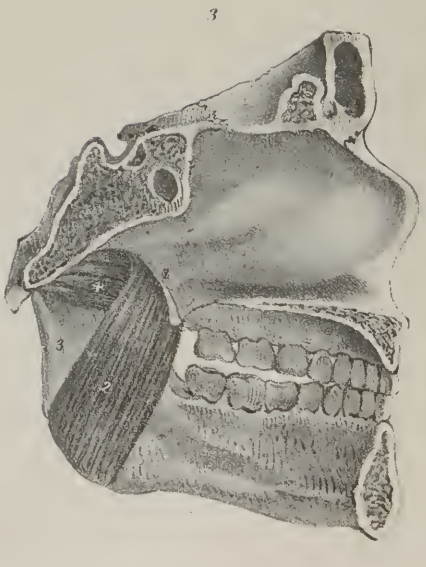

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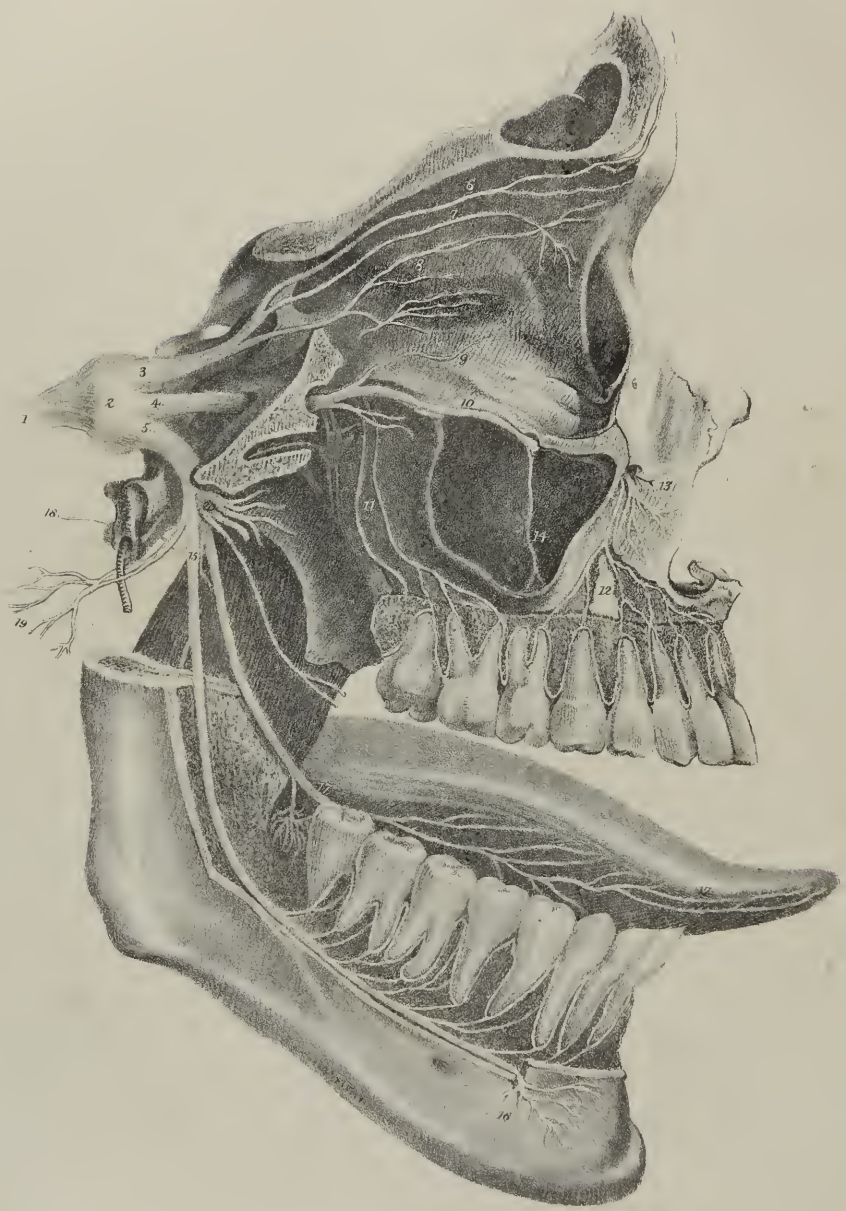

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PLATE XIV.

(*From Quain.*)

THE FIFTH PAIR OF NERVES, OR TRIFACIAL, (*Trigeminus.*)

1. Root of the nerve.
2. Ganglion of Casser.
3. First branch, ophthalmic nerve.
4. Second branch, superior maxillary nerve.
5. Third branch, inferior maxillary nerve.
6. Frontal nerve.
7. Lachrymal nerve.
8. Nasal nerve.
9. Malar branch.
10. Infra-orbital nerve.
11. Posterior dental nerves to molares.
12. Anterior dental nerves to front teeth.
13. Terminating branches of infra-orbital.
14. Middle dental nerve.
15. Inferior dental nerve.
16. Terminating branches of same to the chin.
17. Lingual nerve joined by
18. The chorda tympani.
19. Superficial temporal nerve.
20. Five muscular branches, viz., two temporal, two pterygoid, and one buccal, to the muscles of the same name.

PLATE XV.

(*From Bourgery and Jacob.*)

APPLICATION OF THE KEY TO THE LOWER TEETH.

1. To the first molar, left side.
2. To the second molar, right side, tooth lifted.
3. To the dens sapientiæ, left side.
4. To the same tooth on the right side, the fulcrum resting partly on the second molar.

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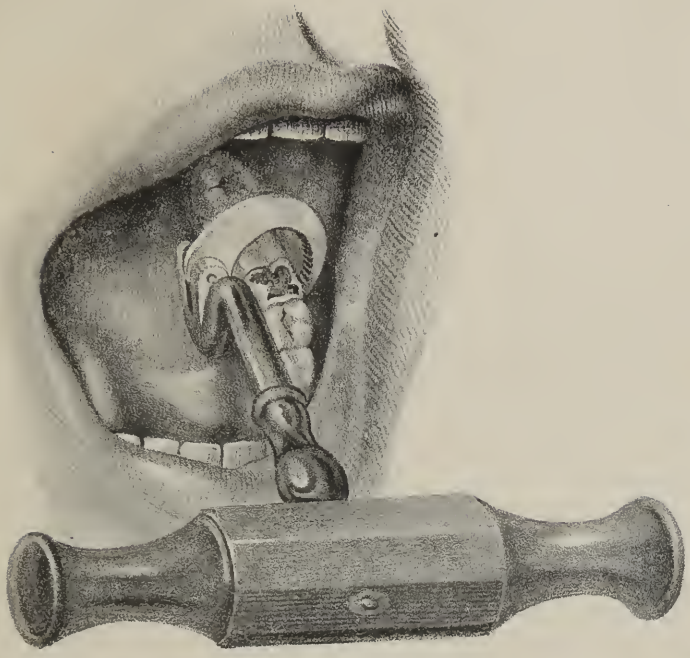

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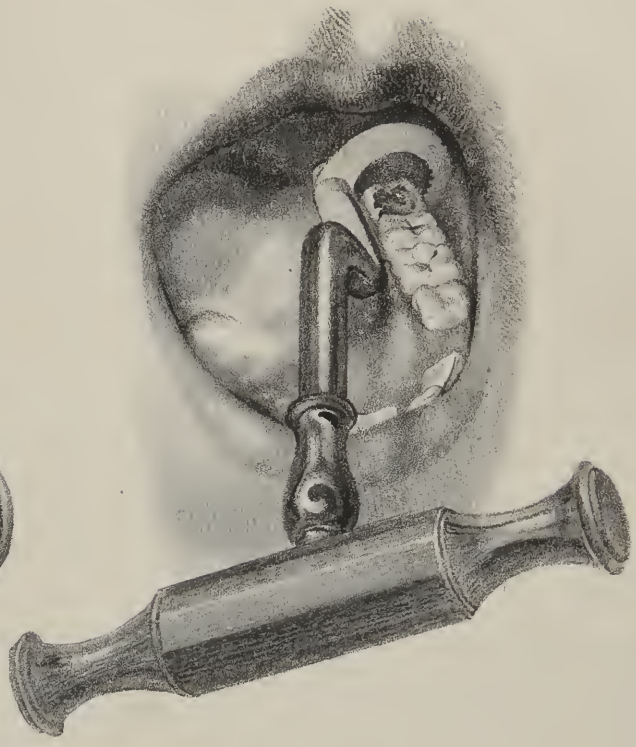

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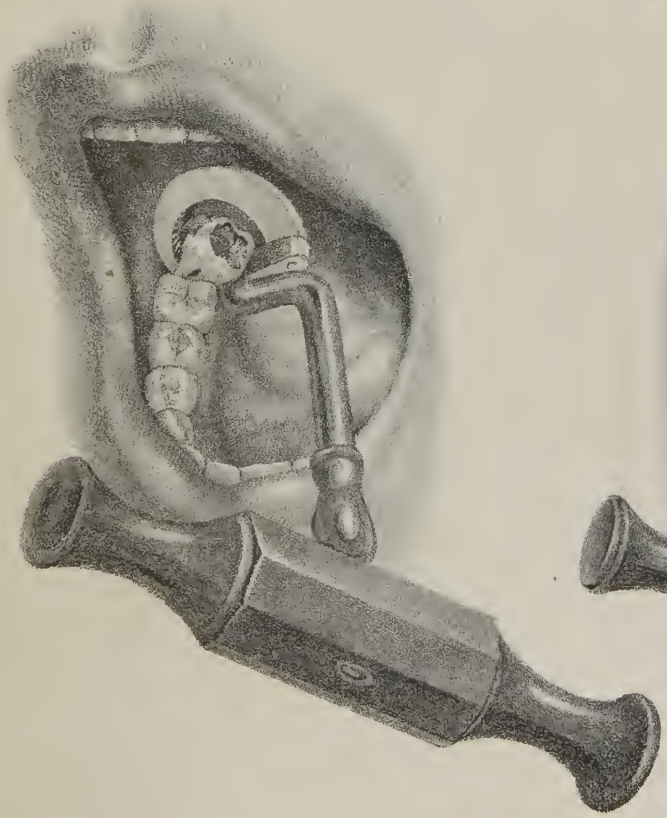

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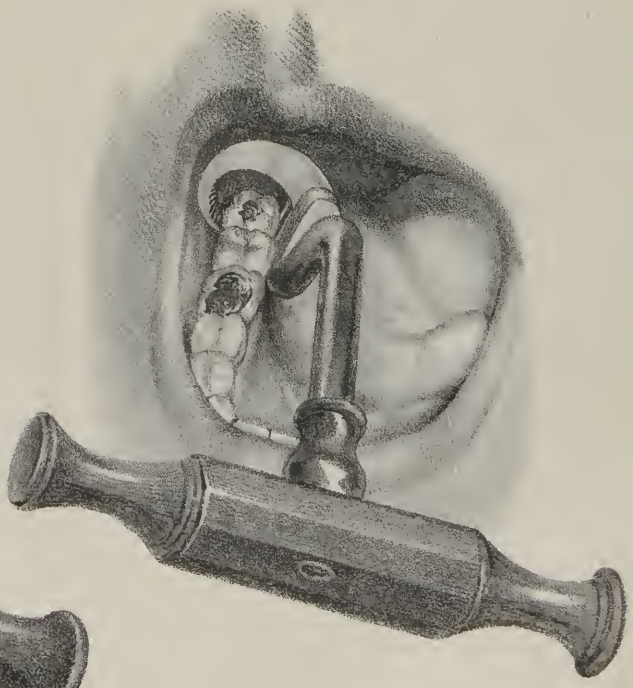

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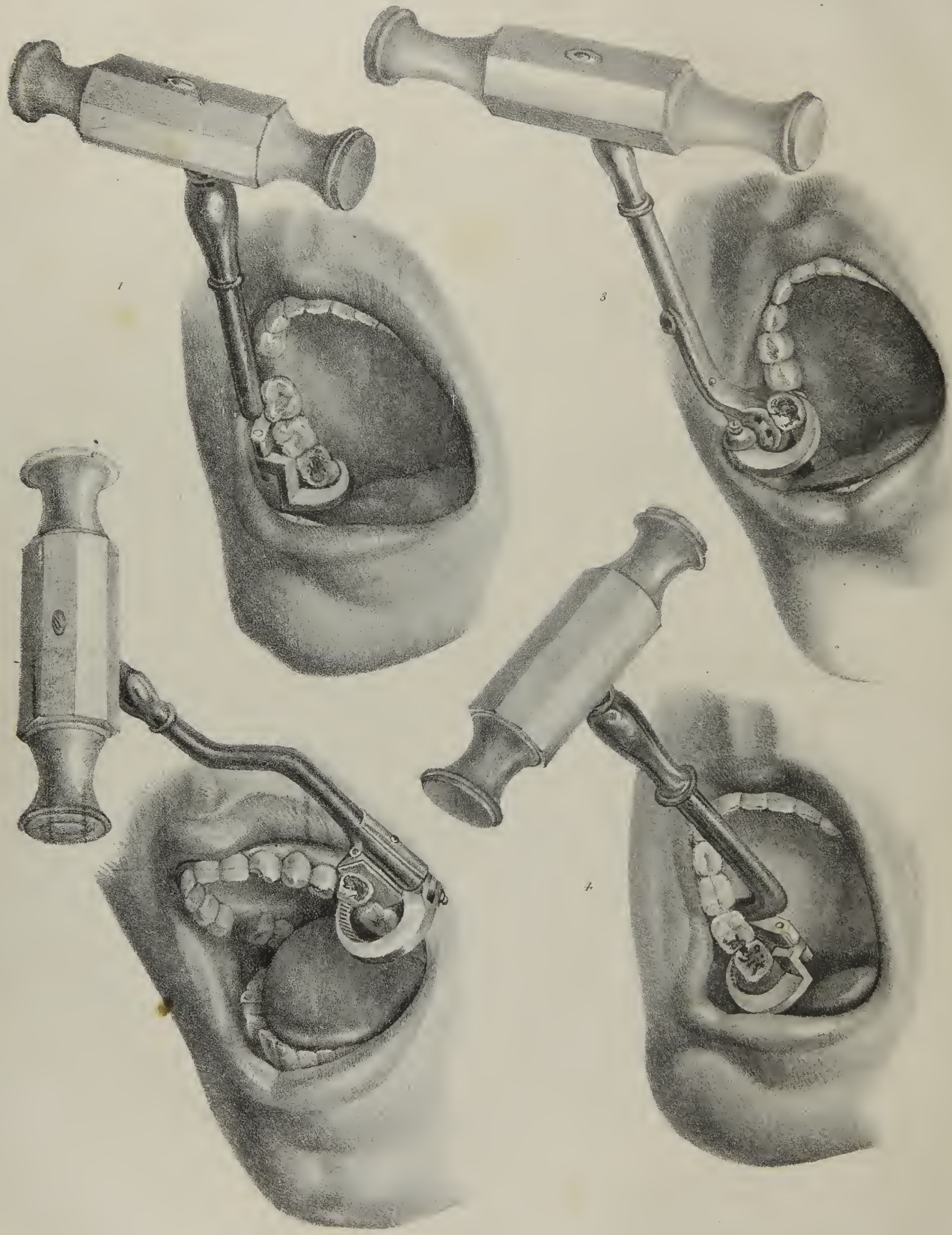

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PLATE XVI.

(*From Bourgery and Jacob.*)

APPLICATION OF THE KEY TO THE UPPER TEETH.

1. To the dens sapientiæ, right side, claw bent and fulcrum resting on second molar.
2. To the first molar, left side, movable fulcrum.
3. To the first molar, right side, round fulcrum.
4. To the dens sapientiæ, right side, fulcrum on the inside.

PLATE XVII.

(*From Nature.*)

VARIOUS FORMS OF THE KEY INSTRUMENT.

1. Large key. The claw and fulcrum both turn on an axis.

1. *a.* Same key seen sideways.

1. *b.* End view of the same.

2. Key, the claw of which turns on an axis and locks in three positions; fulcrum small and round.

2. *a.* End view of the same instrument.

2. *b.* View from above of the same, showing the mode of locking the claw.

3. Side view of a good plain key; probably the most useful form.

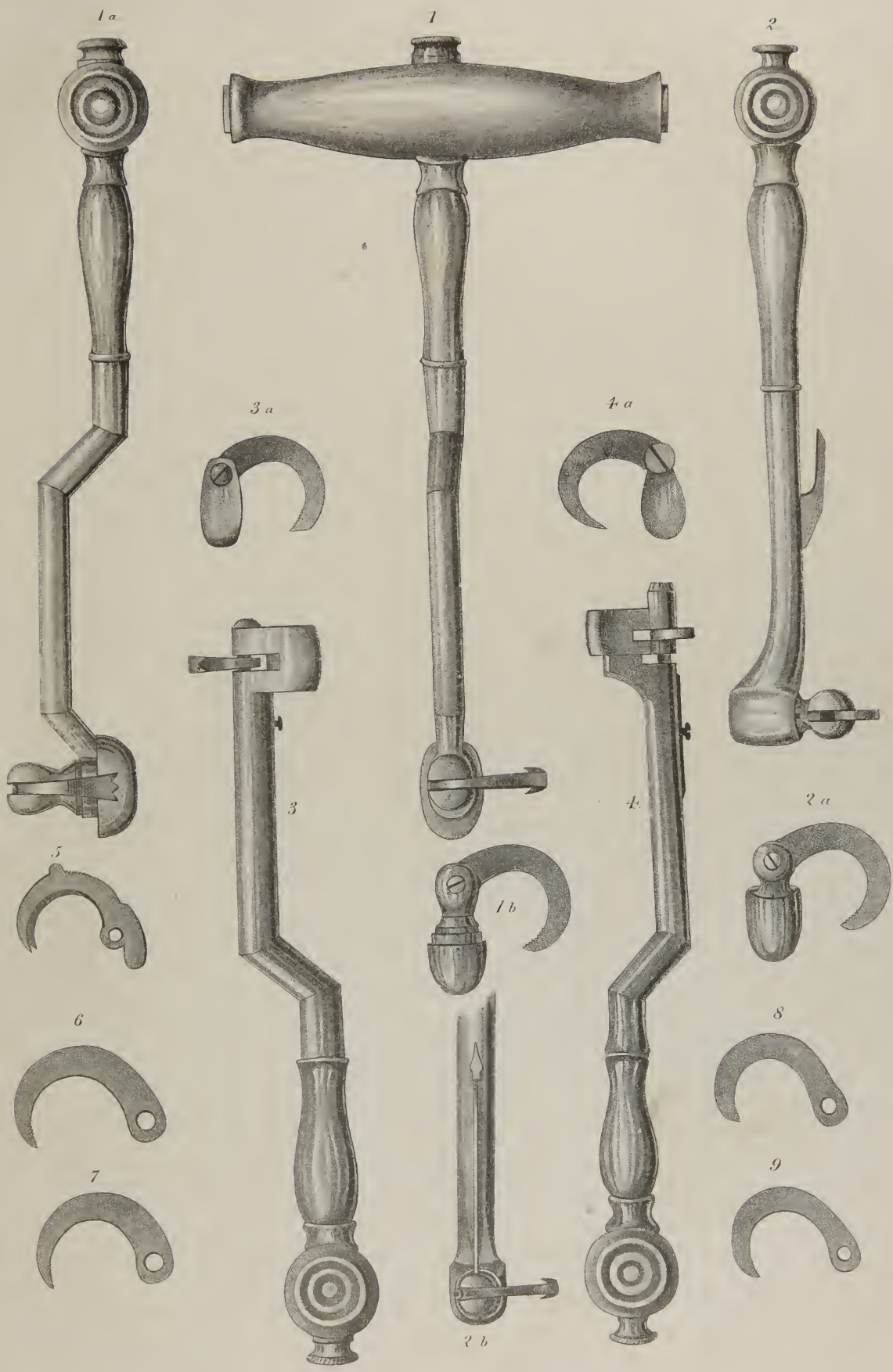
3. *a.* End view of the same instrument.

4. Side view of a key with two slots for the claw.

4. *a.* End view of same key.

5. Mr. Prideaux's claw.

6, 7, 8, 9. Claws of various sizes.



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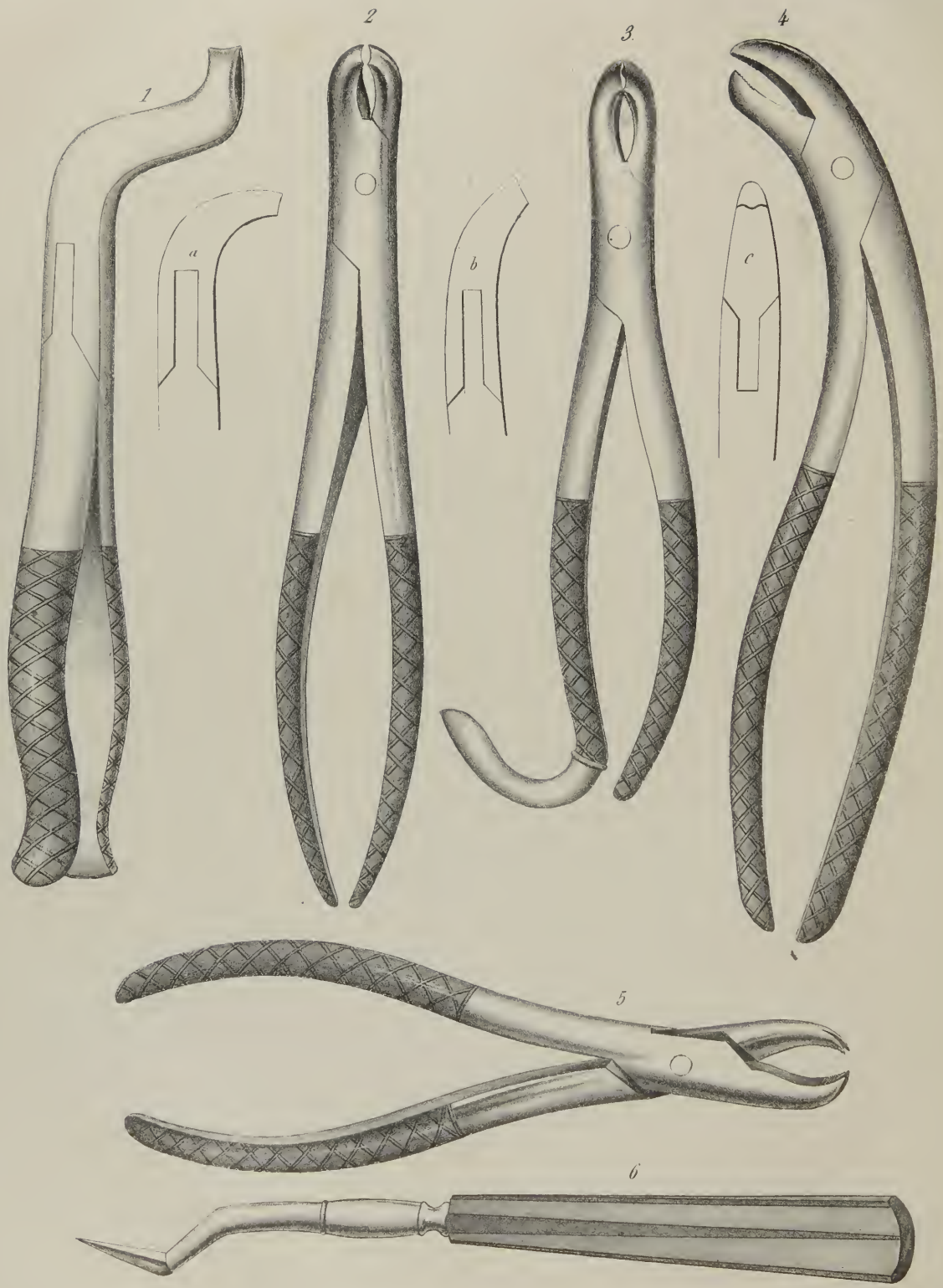

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PLATE XVIII.

(*From Nature.*)

FORCEPS AND ELEVATOR.

1. Forceps bent twice, for wisdom teeth of upper jaw.
2. Bent forceps, for lower molares and bicuspidati.
3. Bent forceps, in pairs, for upper molares, first and second; this pair is for the left side.
4. Hawk's-bill forceps, for upper molares, right side, standing behind; or for lower molares, either side.
5. Straight forceps, for incisors and cuspidati.
6. Elevator, for snags and wisdom teeth.

PLATE XIX.

(*From Nature.*)

FORCEPS.

1. Hawk's-bill curved twice, for upper molares, right side, the operator standing behind; they will also do for the lower molares on the left side.

1. *a.* Under view of same instrument.

2. Common hawk's-bill forceps, for lower incisors, cuspidati, and sometimes bicuspidati.

3, and 3. *a.* Small pair of bent forceps, for snags.

4, and 4. *a.* Large bent forceps with a hook in the handle, for the lower molares and bicuspidati on the left side.

5, and 5. *a.* Small double-bent forceps, for snags far back in the mouth.

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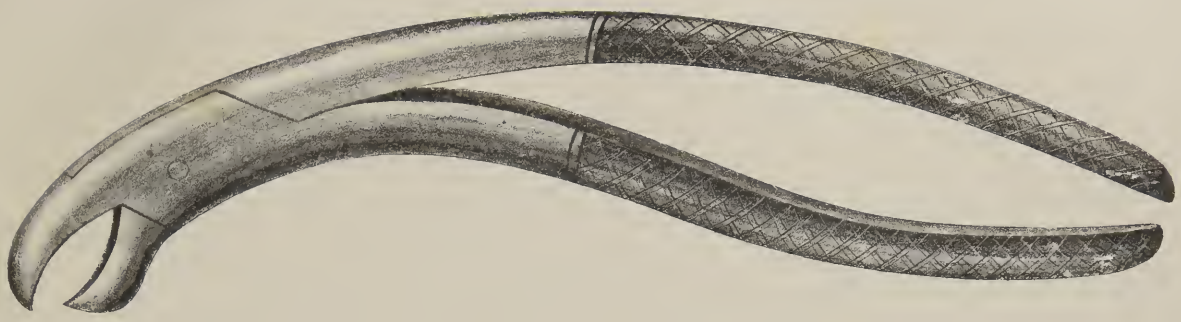

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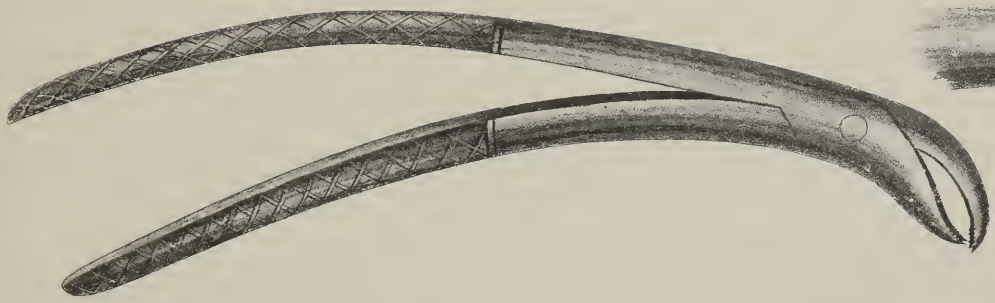

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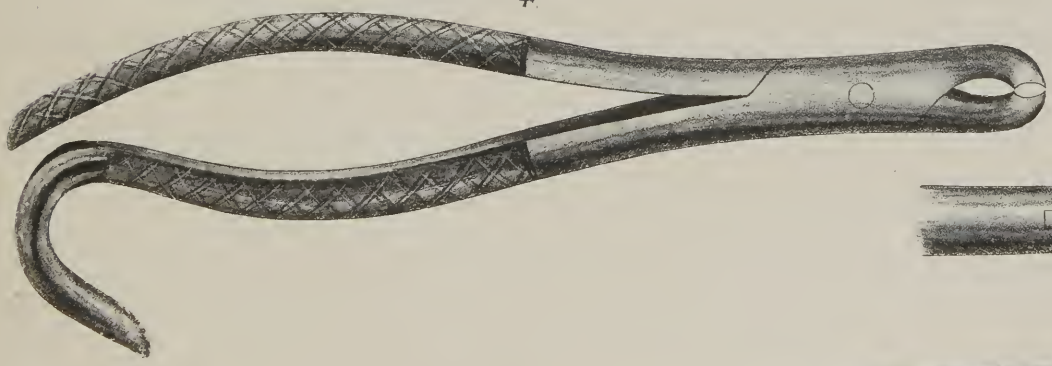

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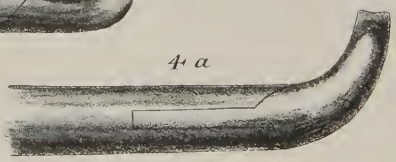

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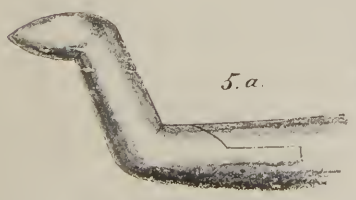

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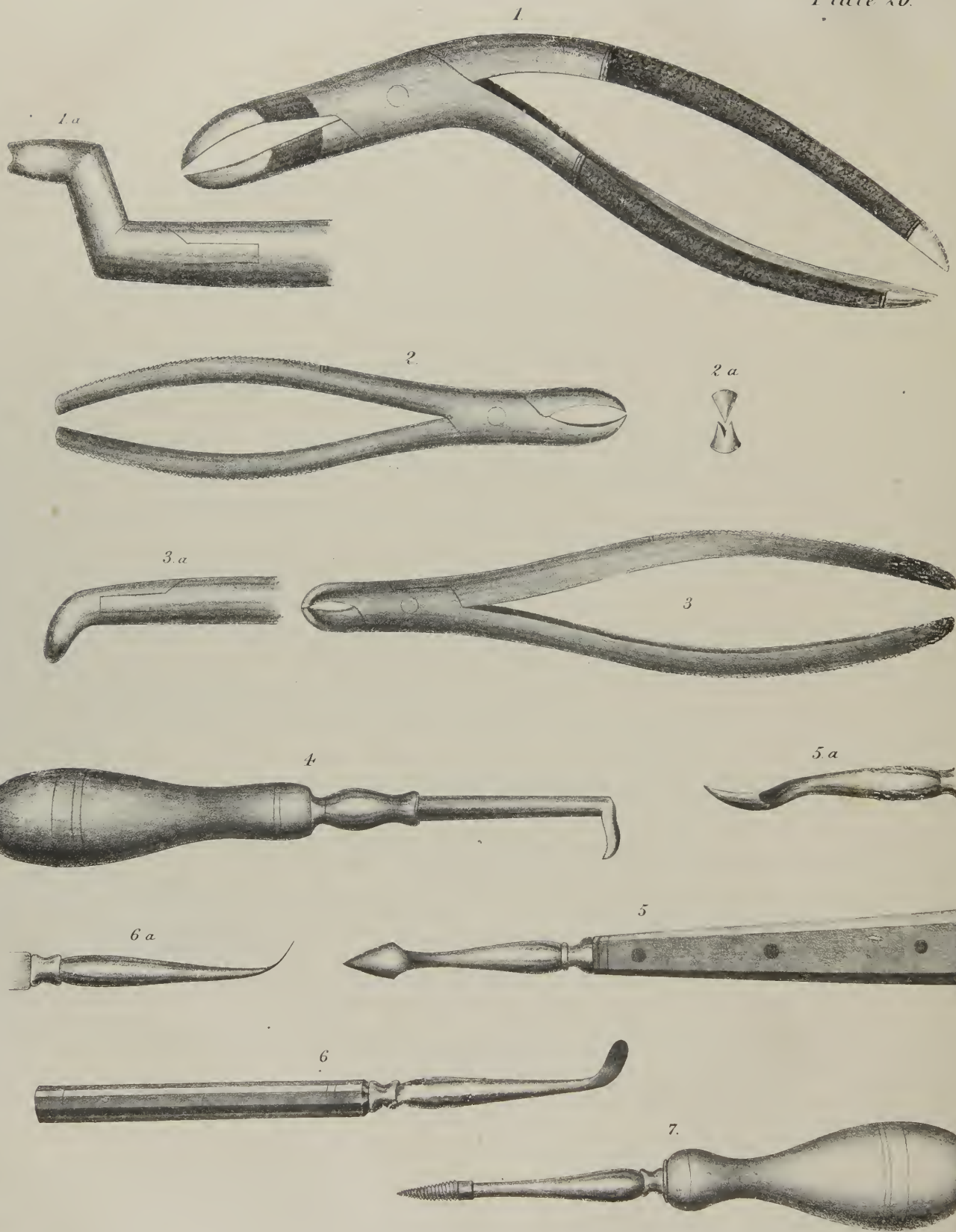

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PLATE XX.

(*From Nature.*)

1, and 1. *a*. Double-bent hawk's-bill forceps in pairs, for molares in either jaw. The one represented is for the right side.

2, and 2. *a*. Straight forceps, adapted to remove crowded incisors, the single point passing between them.

3, and 3. *a*. Bent forceps for snags and small bicuspides.

4. The hook elevator, to act from behind, forwards.

5, and 5. *a*. The spoon elevator.

6, and 6. *a*. A gum lancet, for the back teeth.

7. The conical screw, for fangs which have been used to pivot teeth to.

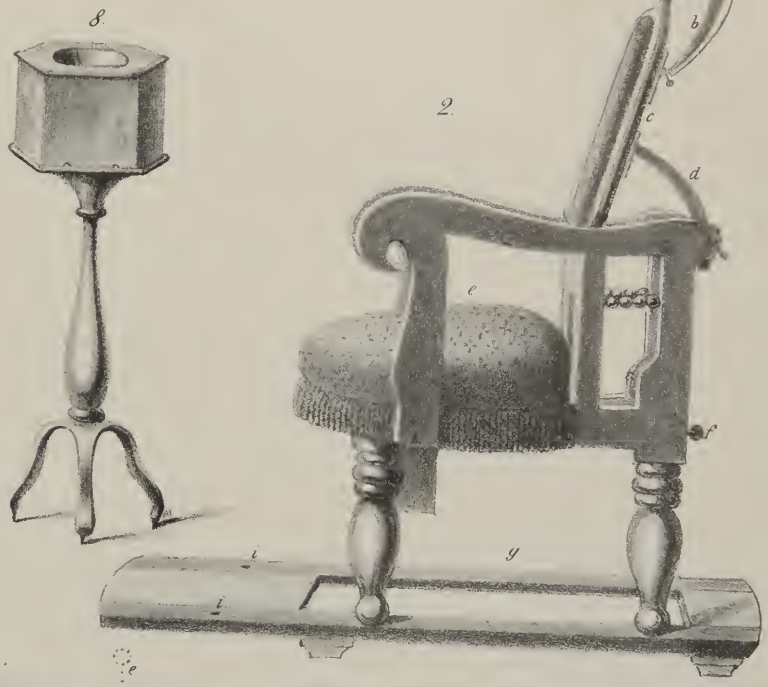
PLATE XXI.

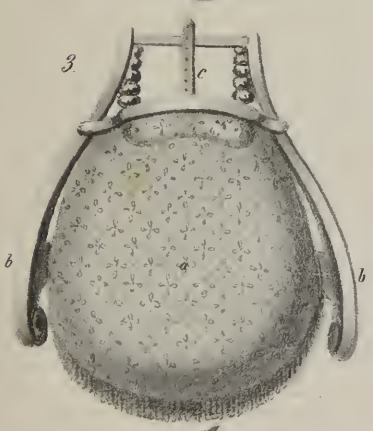
(*From Nature.*)

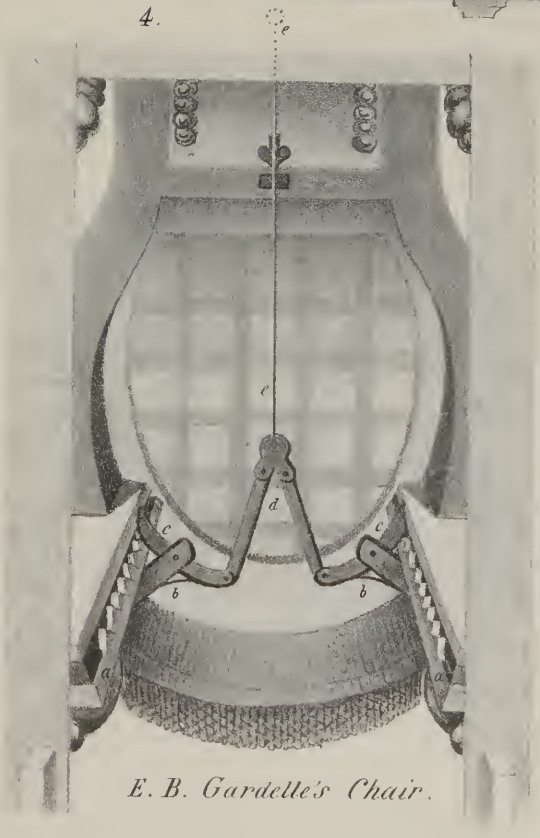
DR. E. B. GARDETTE'S OPERATING CHAIR.

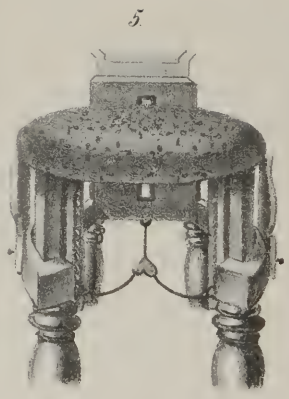
This chair was contrived by Dr. Gardette, of Philadelphia, and made under his direction.

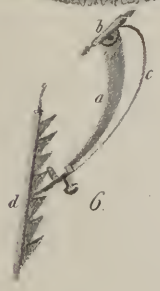
1. Front view of the chair.
2. Side view of ditto.
   - *a.* The head piece.
   - *b.* The movable support for ditto, see figure 6.
   - *c.* The back, movable backwards by means of
   - *d.* The perforated arc supporting the back, (see figure 7.)
   - *e.* The seat rising and falling, (see figure 4.)
   - *f.* The button, by pressing which the seat is let down, (see *e.* figure 4.)
   - *g.* The base of the chair.
   - *h.* The screw which enables the operator to remove the arms.
   - *i.* Holes for fastening a stool.
3. Bird's-eye view of the chair.
   - *a.* The seat.
   - *b. b.* The arms.
   - *c.* The perforated arc.
4. View of the chair from beneath, to show the ratchet and clicks which support the seat at any desirable height.
   - *a.* Pieces of wood to which the ratchets are screwed.
   - *b. b.* Springs pressing on the clicks.
   - *c. c.* Clicks or catches holding by the ratchets.
   - *d.* Links connecting them to a common centre, so that they may be moved simultaneously.
   - *e. e.* Rod going out from the links, and terminating in a button at the extremity.
5. Front view of seat, with the fringe removed, and the clicks detached.
6. Catch and spring to support the head-piece.
   - *a.* The catch.
   - *b.* Piece screwed to the head-board.

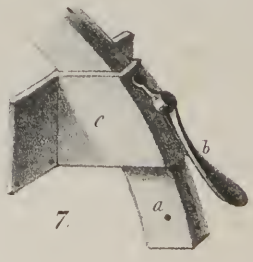












E. B. Gardette's Chair.

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c. Spring.

d. Ratchet screwed to the back.

7. Part of the perforated arc, for the support of the back.

a. Part of the arc.

b. Flute key-catch dropping into the holes in the arc.

c. Plate carrying the catch and screwed to the solid part of the chair, as seen at figure 2.

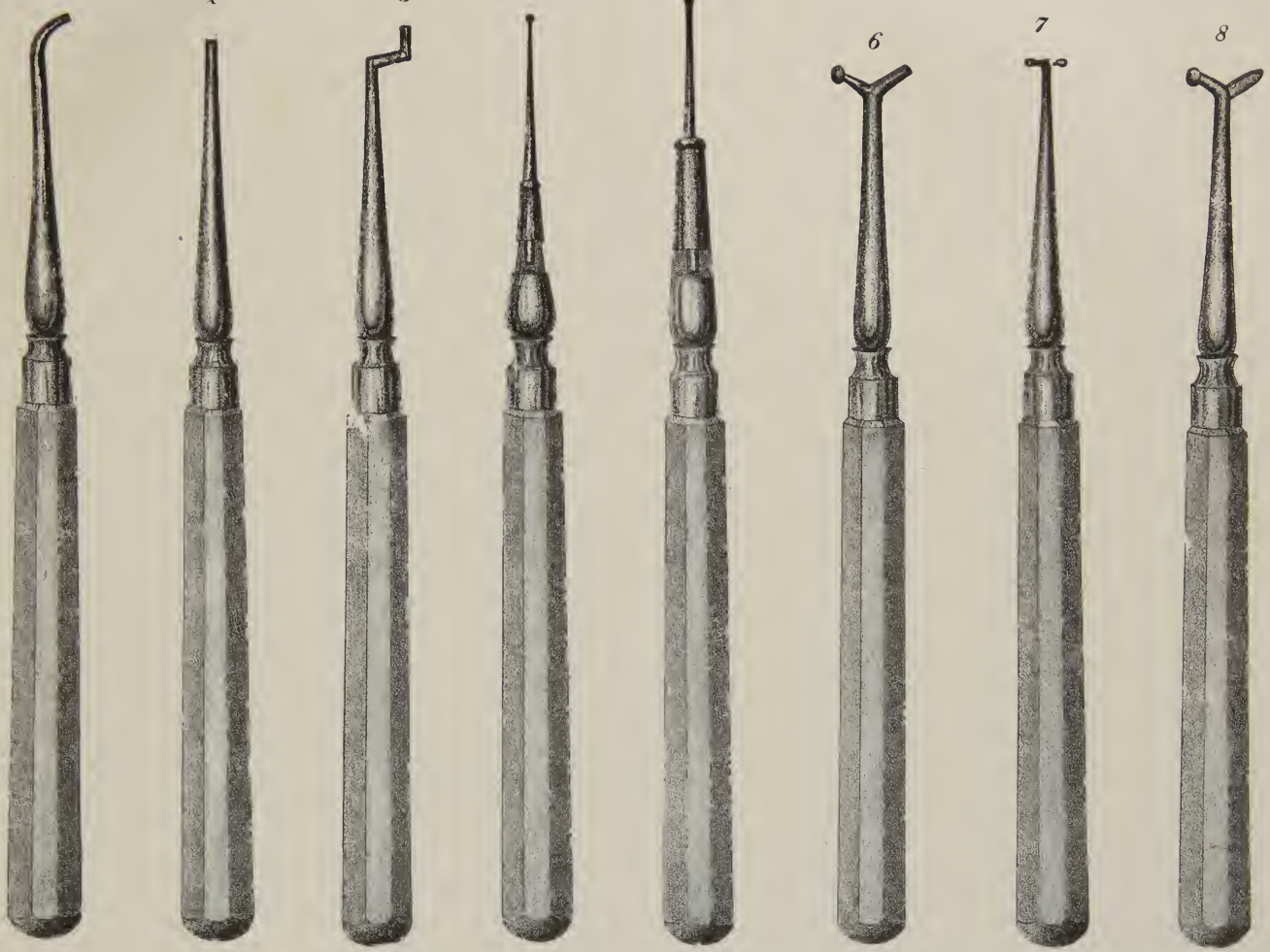
8. Dentist's spittoon.

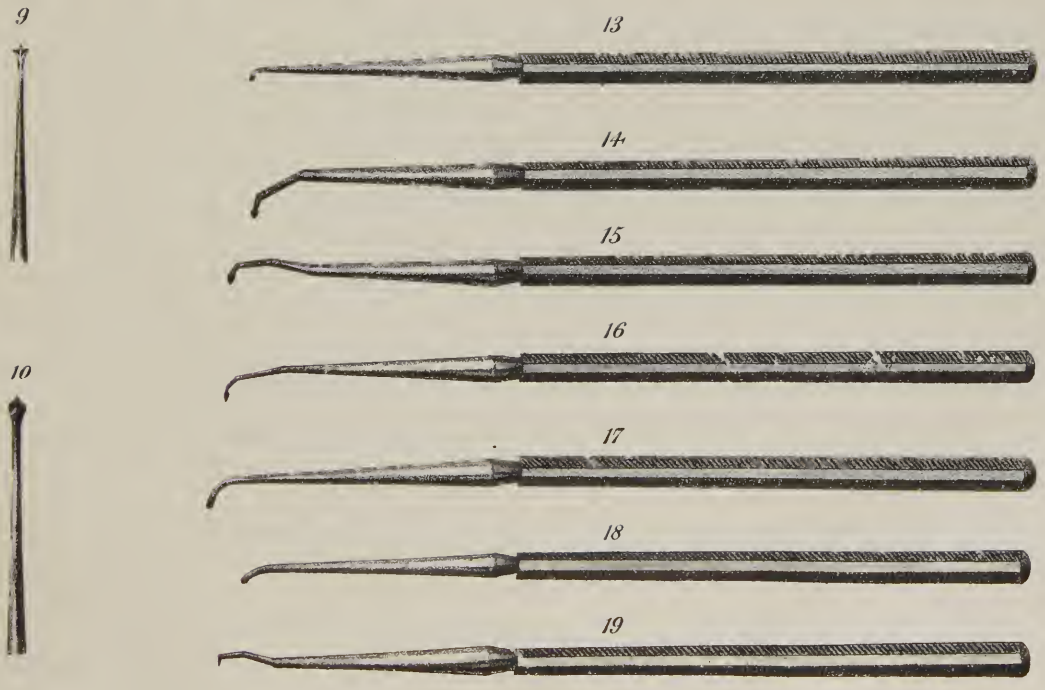
PLATE XXII.

(*From Nature.*)

INSTRUMENTS USED IN THE OPERATION OF PLUGGING.

1, 2, 3. Pluggers for pressing in the foil.
4. Rose drill.
5. Common drill.
6. Burnisher.
7. Small burnisher.
8. Burnisher.
9, 10. Drills of an improved form.
11, 12. Rose drills.
13 to 19. Excavators for cutting out the decayed and softened ivory.





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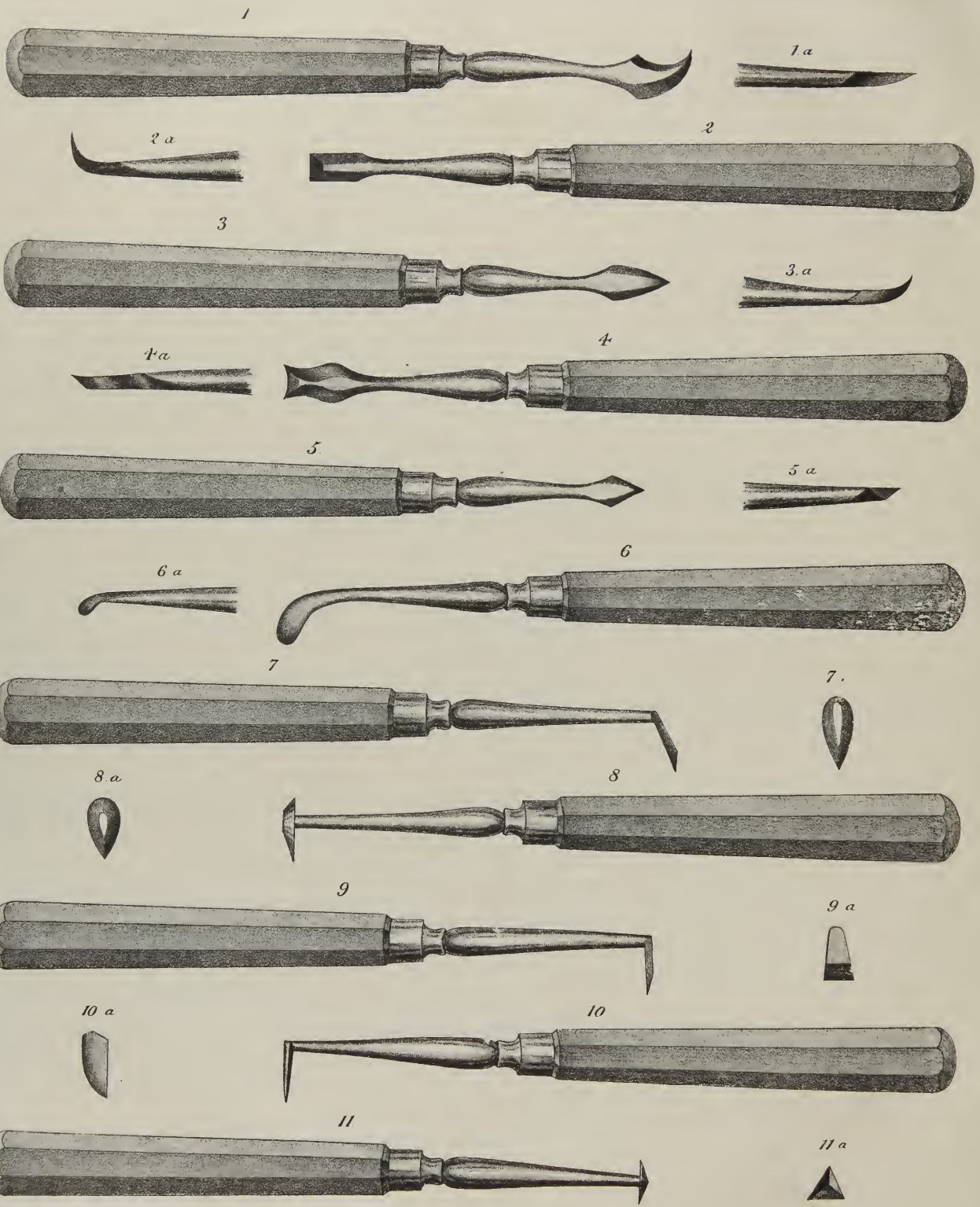

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W. E. Smith del.

PLATE XXIII.

(*From Nature.*)

SCALING INSTRUMENTS OF VARIOUS FORMS, TO SUIT ALL THE IRREGULAR CAVITIES ABOUT THE TEETH.

These instruments are used solely for removing the tartar which accumulates about the teeth.

PLATE XXIV.

(*From Nature.*)

CABINET LATHE, GRINDING APPARATUS AND WORK BENCH.

1. Cabinet closed; forming an ornamental piece of furniture.

2. Ditto opened to work at; a leather apron to catch the gold scraps and filings, is nailed to a frame which slides in the rebates under the bench, which last pulls out like a drawer when wanted.

3. Cabinet opened so as to use the lathe, showing a row of small drawers for containing the wheels, &c.

4. Chuck for holding the grinding wheels.

a. Body of the chuck.

b. Screw.

c. Nutt.

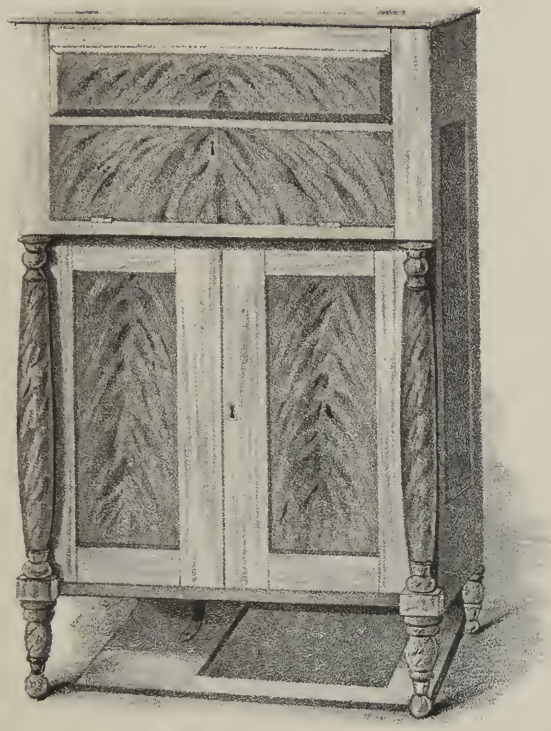
5. Small oil can.

6. Brush for scouring and polishing gold plates.

7 to 11. Grinding wheels of various shapes, made of a mixture of shellac and emery, cast in moulds, and subjected to a strong compression. They are to be kept wet while in use, by means of a large sponge, which may be dipped in water and held against the revolving grinder by means of a wire spring.

This plan prevents the water from accumulating on the periphery of the wheel and flying off in drops.

1



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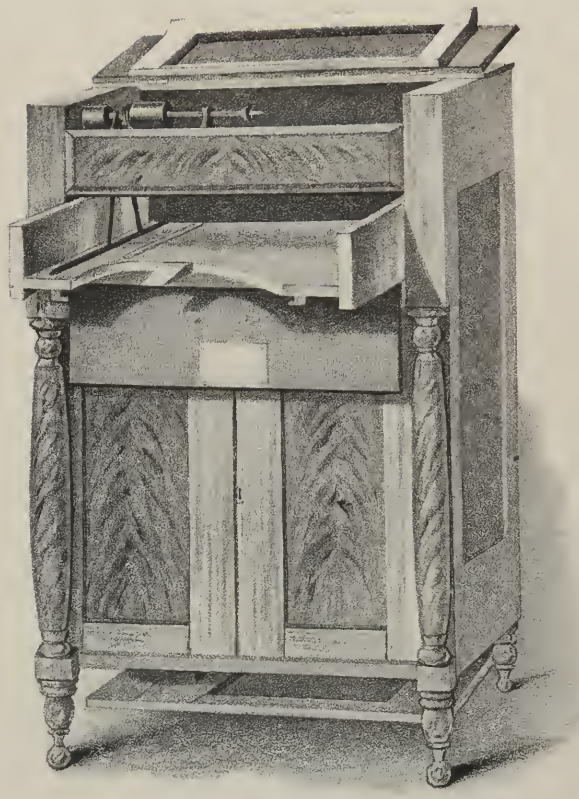

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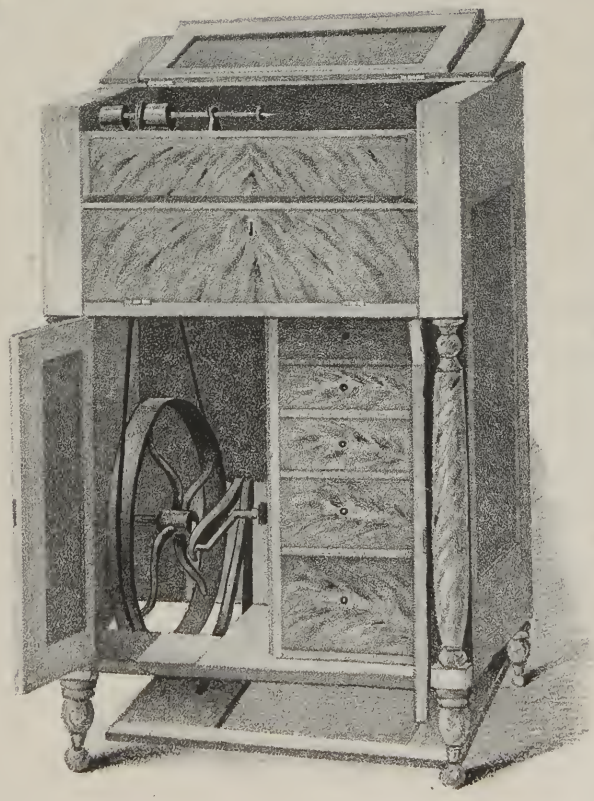

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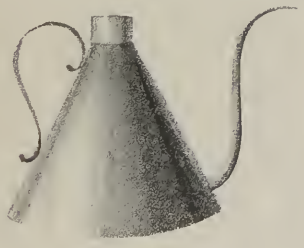

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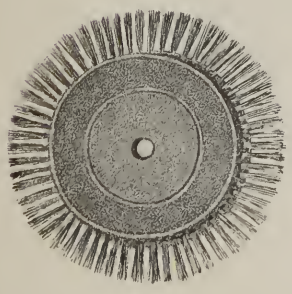

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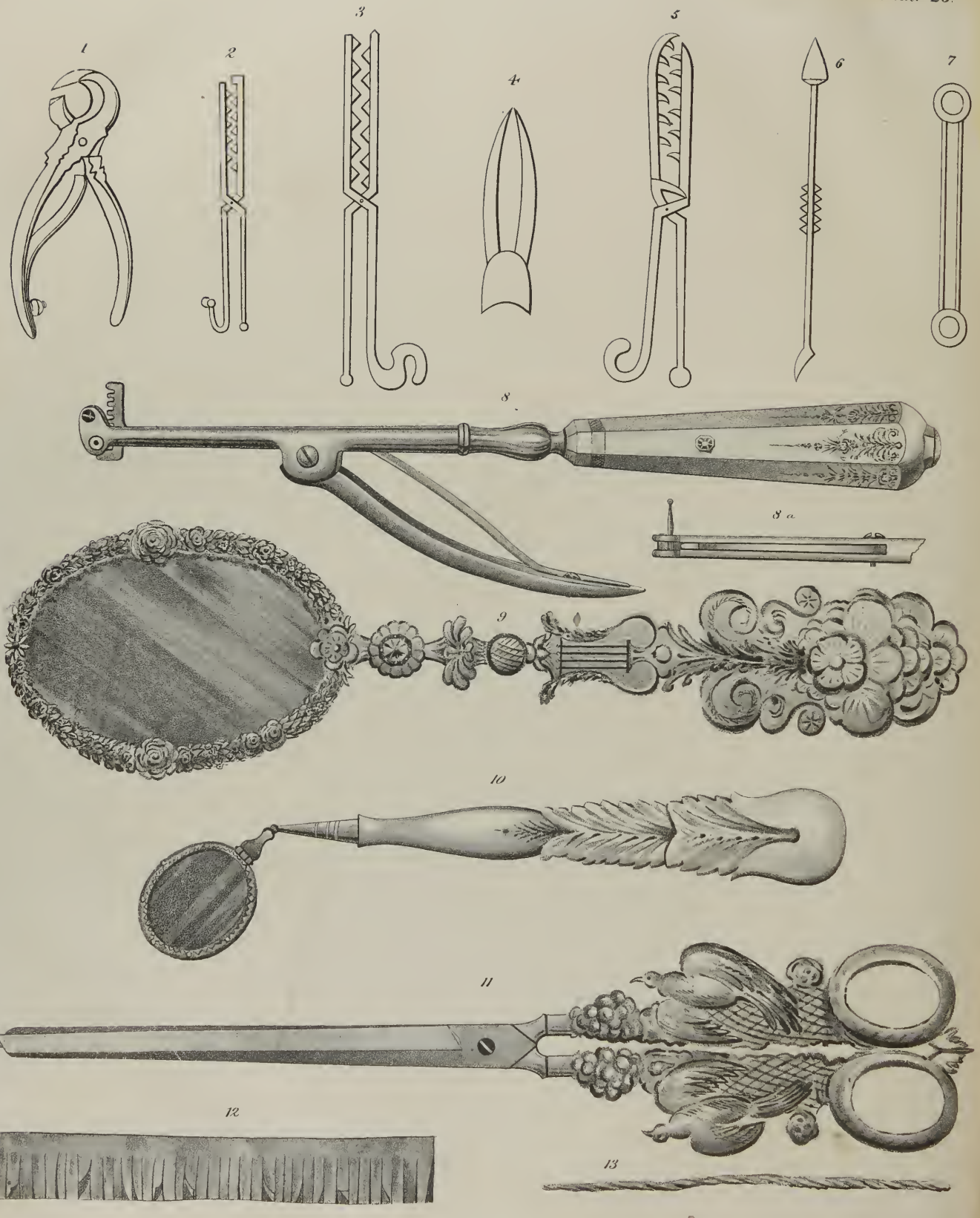

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PLATE XXV.

(*From Snell and Nature.*)

ANCIENT AND MODERN INSTRUMENTS.

1. The vulsellum of CELSUS. (See Paragraph 7.)

2, 3, 4, and 5. The instruments of ALBUCASIS, for shaking the teeth well. (See Paragraph 13.)

6, 7. Instruments used by the ancient surgeons for applying the actual cautery to the teeth.

8. Dental mirror.

9. Ditto, on a joint to be placed in the mouth to enable the operator to see the backs of the teeth.

10. Foil scissors for cutting the gold and tin foils.

11. A strip of foil cut for plugging.

12. The same foil rolled up into a little rope preparatory to being placed in the cavity.

PLATE XXVI.

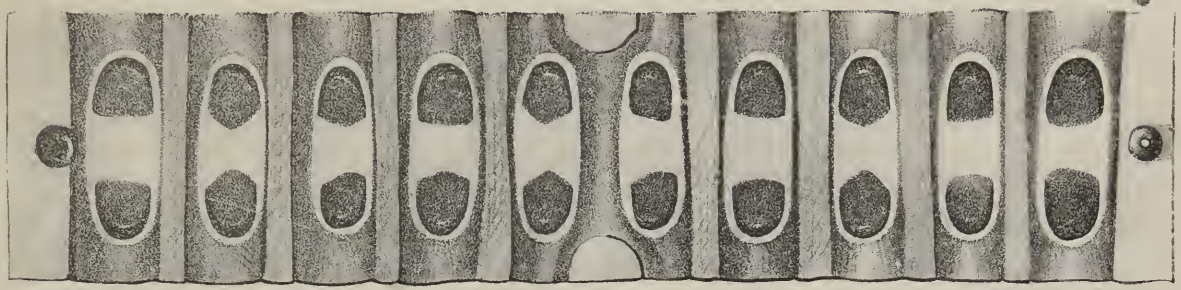
(*From Nature.*)

MOULDS FOR VARIOUS KINDS OF TEETH.

1. Mould for pivot teeth, incisors and cuspidati.
   - A. Upper view of B, showing the holes for introducing the instruments, figures 5 and 6, to make the hole for the pivot.
   - B. The upper piece of the mould.
   - C. The lower piece.
2. Mould for plate teeth, bicuspidati and molares.
   - D. Upper piece.
   - E. Lower piece.
3. Mould for plate teeth, cuspidati and bicuspidati.
   - F. Upper piece.
   - G. Lower piece.
4. Mould for plate teeth, incisors and cuspidati.
   - H. Upper piece.
   - I. Lower piece.
5. Gouge or scoop for the pivot holes.
6. Round smooth instrument, to be used afterwards.

1

A



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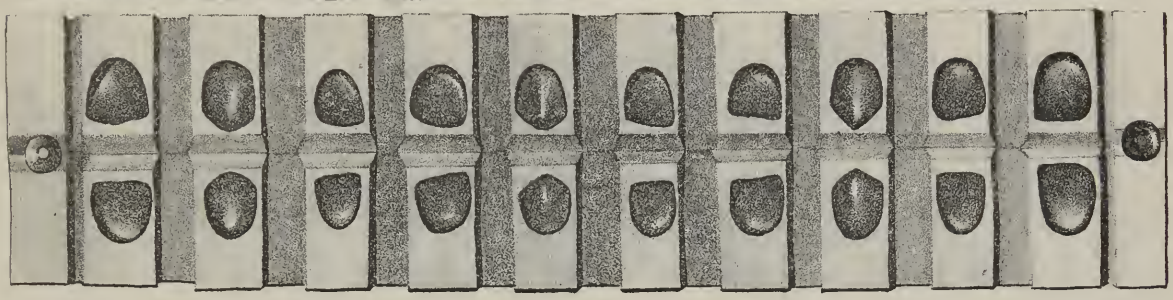

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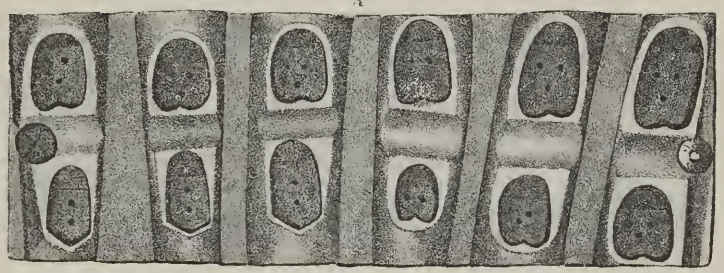

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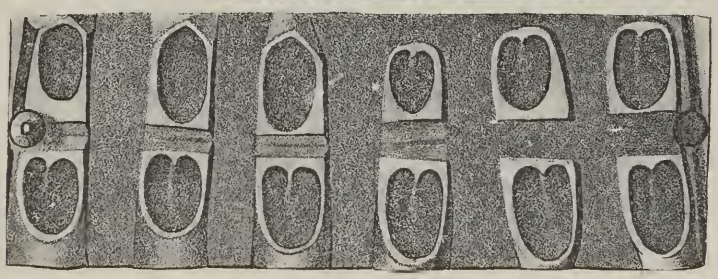

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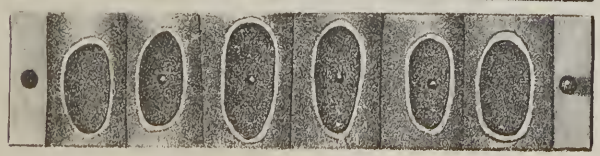

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Plate 27

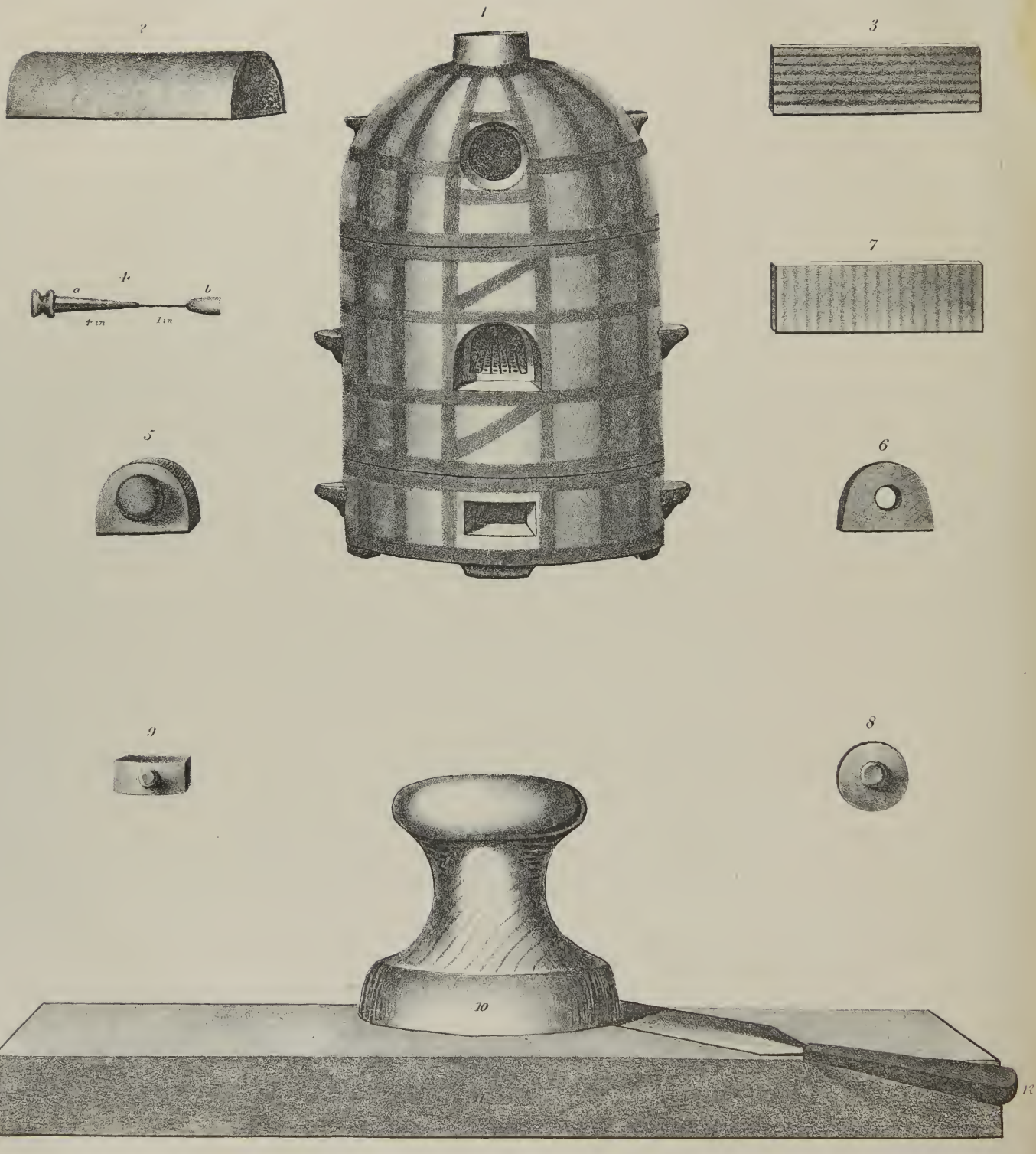

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PLATE XXVII.

(*From Nature.*)

MUFFLE FURNACE AND ACCOMPANIMENTS.—SLAB AND MULLER.

1. Muffle furnace, with four openings;—1. collar for stove-pipe; 2. upper door to supply fuel; 3. muffle door, and 4. ash-pit door.
2. Muffle.
3. Slide for plate teeth, with longitudinal grooves.
4. Test piece.
    a. Fire clay part.
    b. Tooth to be tested; the platina wire is between the two.
5. Outer cover for muffle.
6. Inner cover for ditto, carrying the test piece.
7. Slide for pivot teeth; grooves transverse.
8. Stopper, for upper door.
9. Stopper, for ash-pit.
10. Muller of wedgewood, with a wooden handle.
11. Slab of porphyry or glass, set in plaster paris.
12. Spatula, to handle the materials.

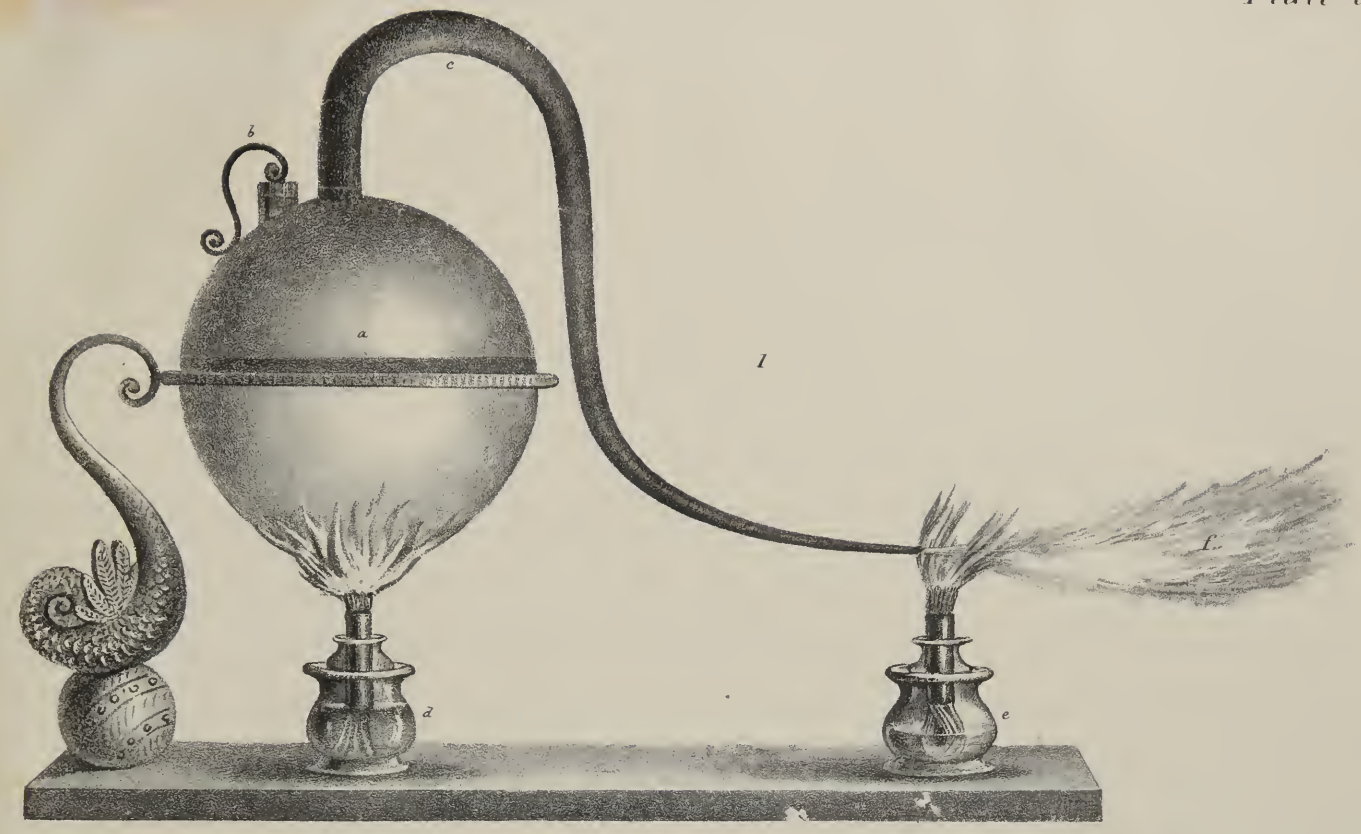
PLATE XXVIII.

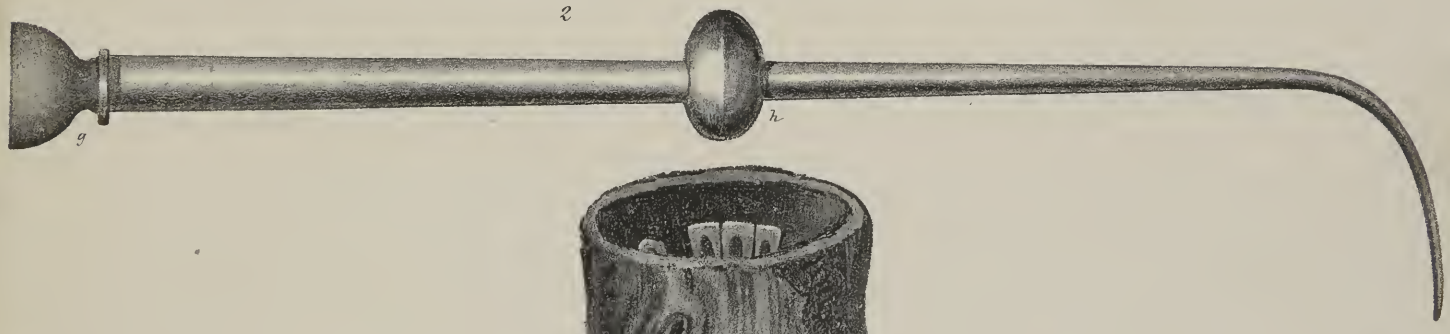
(*From Nature.*)

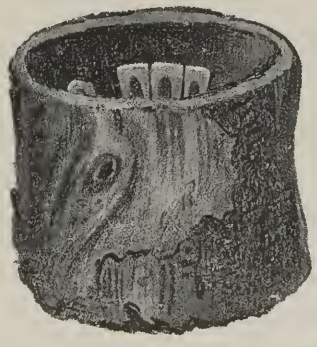
IMPLEMENTS FOR SOLDERING.

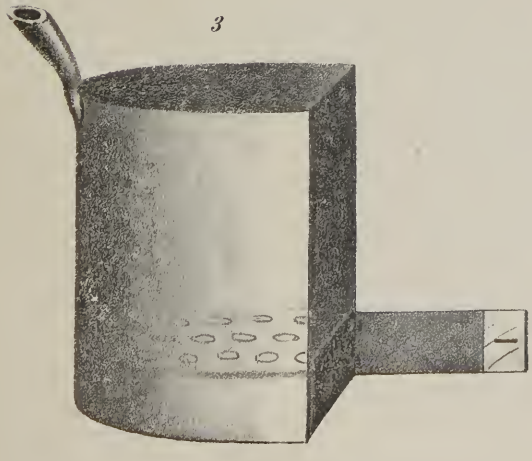
1. Eolipile in action. Alcohol is to be put into the lamps, and also into the ball or boiler.
   - *a.* The boiler.
   - *b.* The safety valve.
   - *c.* The tube to conduct the vapour, forming the blow-pipe.
   - *d.* The lamp to boil the alcohol.
   - *e.* The lamp to keep up the combustion of the vapour, which without it, would blow itself out. This flame need not be very large.
   - *f.* The flame.

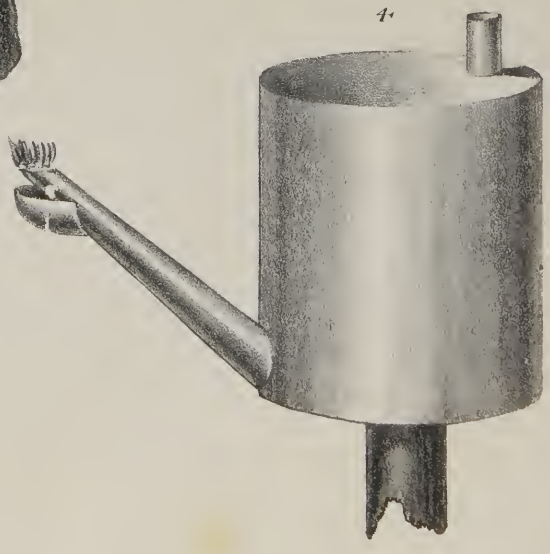
   The above was drawn from an instrument used by the eminent machinist, Isaiah Lukens.
2. Mouth blow-pipe.
   - *g.* The mouth piece.
   - *h.* The bulb to condense the moisture of the breath.
3. The soldering furnace, to solder blocks and single teeth to the gum-plate.
4. The soldering lamp, to be used with the mouth blow-pipe. It is supplied with alcohol.
5. Charcoal scooped out to hold teeth when they are soldered to their stays. This may be surrounded with a coat of plaster and sand, which makes it more cleanly.











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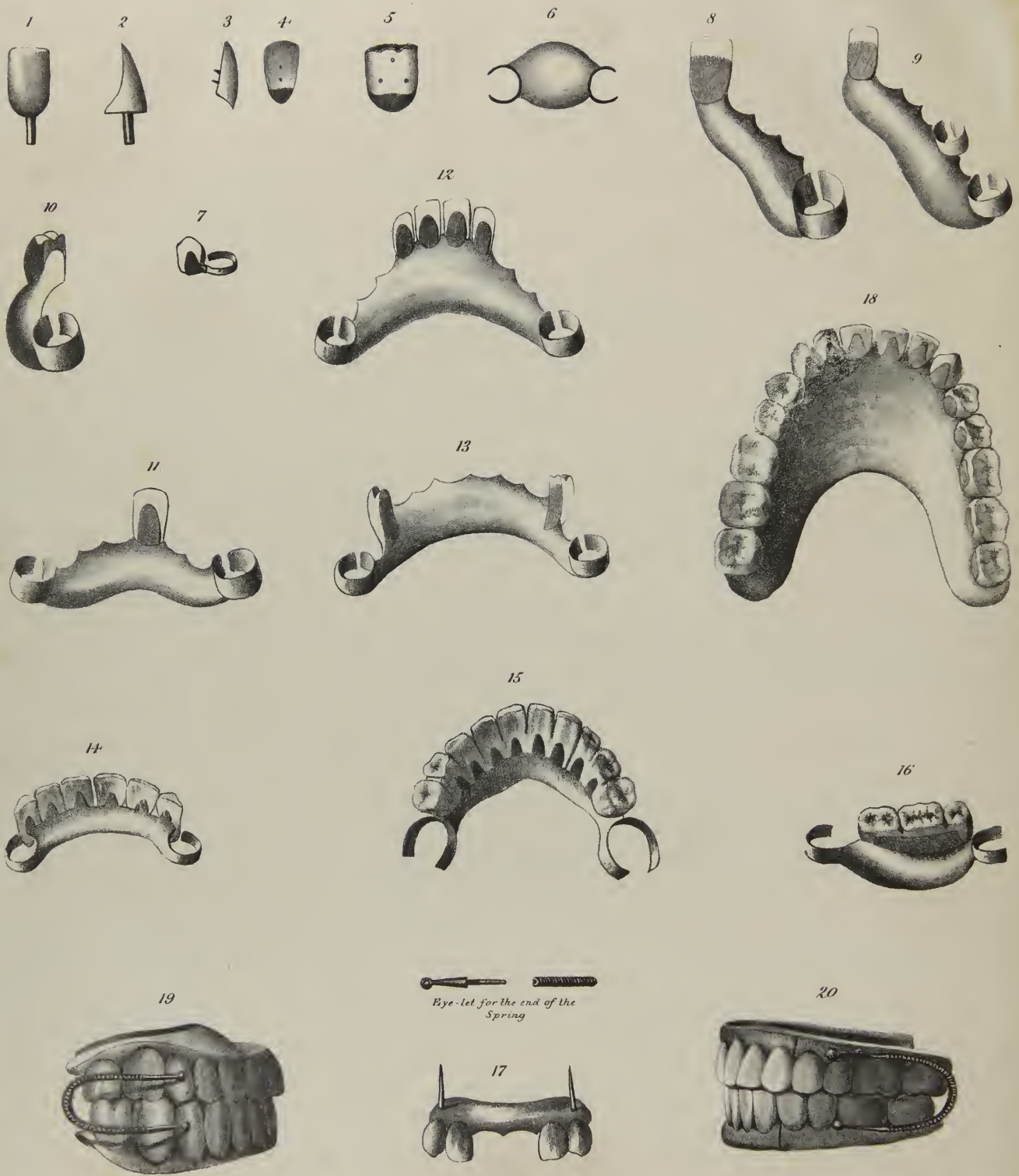

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PLATE XXIX.

(*From Nature.*)

VARIOUS FORMS OF ARTIFICIAL TEETH AND PLATES.

1 and 2. Front and side view of a pivot tooth with its pivot.
3 and 4. Back and side view of a plate tooth, with its platinum pins.
5. Back view of a molar plate tooth with three pins.
6. Plate for one or two teeth, to be connected to their neighbours.
7. Cuspidatus and clasp, for bicuspid.
8. Central incisor and clasp, for first molar.
9. Same tooth and clasp, for first bicuspid and first molar.
10. Bicuspid and clasp, for a molar.
11. Central incisor and two clasps, for the opposite bicuspids.
12. Four incisors and clasps, for first molars.
13. Two first bicuspidati and clasp, for first molars.
14. Incisors and cuspidati with clasp, for first bicuspidati.
15. The ten anterior teeth and clasps, for first molars.
16. A block of three molars, stay running the whole length.
17. Lateral incisors and cuspidati, to be pivoted to the fangs of the cuspid.
18. A full set for the upper jaw on a suction plate.
19. A full set for both jaws, of separate teeth mounted with a spring.
20. A full set of blocks for both jaws, mounted with a spring.

PLATE XXX.

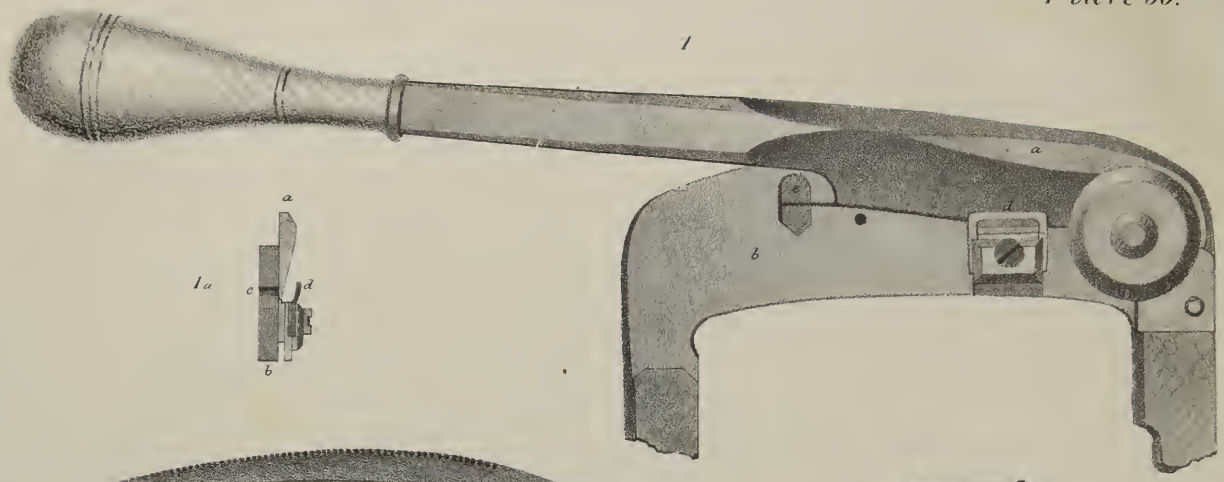
(*From Nature.*)

INSTRUMENTS AND CASTS.

1. An instrument for cutting the platina rivets. The base *b* is screwed to a table, and has four or five holes drilled through it, which should be of different sizes to accommodate several sizes of platina wire; the wire is pushed through one of the holes *c*, figure 1. *a*, until it is arrested by the stop *d*, which is capable of being adjusted; and the blade *a*, coming down first cuts it off, and then flattens the end of it into a kind of a head, the stop *e* preventing it from being entirely cut off.

1. *a*. A section of the instrument.
   - *a*. The cutting blade.
   - *b*. The horizontal fixed bar.
   - *c*. The hole for the wire.
   - *d*. The stop limiting the length of the wire.
2. Punching forceps, for making the holes in the stays to which the teeth are riveted.
3. Cast of an upper jaw, to make a gum plate on.
4. Side view of same cast.
5. Box for holding the wax, when an impression of the mouth is wanted.
6. Evans's patent articulator.
   - *a*. *a*. The back vertical plate, extending down and clamped or screwed to a table.
   - *b*. A horizontal plate, representing the lower jaw.
   - *c*. A vertical plate on each side, representing the ramus of the jaw.
   - *d*. Holes and a pin, by which the length of the ramus may be altered to correspond with a measurement taken from the patient.
   - *e*. A plate representing the upper jaw, which is fixed.
   - *f*. Screw to hold the cast of the upper jaw to the plate *e*.
   - *g*. Spring to press up the lower plate *b*.

1



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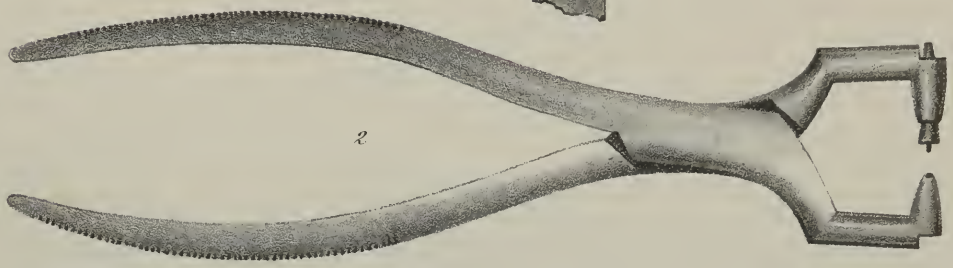

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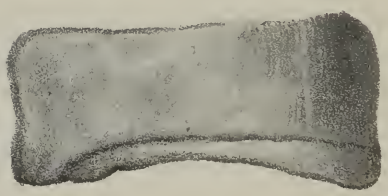

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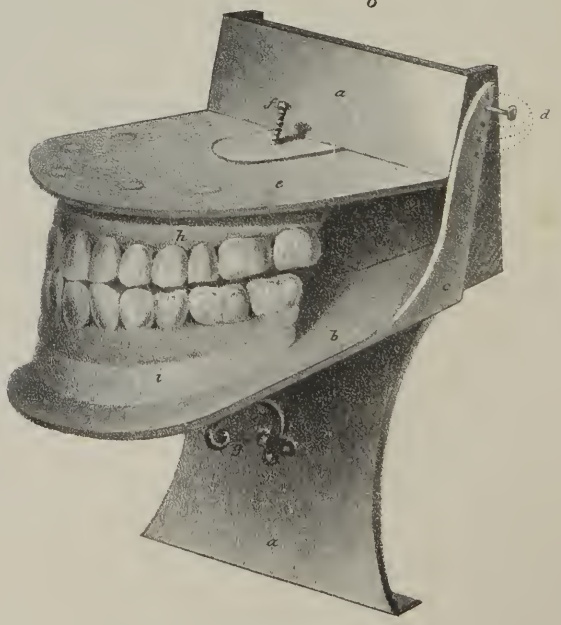

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h. Upper set of false teeth.

i. Lower set of false teeth.

By means of this ingenious instrument, the natural motion of the jaw is given, and the operator can articulate his artificial sets in a very perfect manner.

Mr. Horatio G. Kern, of Philadelphia, is the holder of the patent right, and makes the instrument for sale.